This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

ation Bulletin

Hampshire Agricultural Experiment Station

Digitized by Google

Sci 163635

HARVARD
COLLEGE
LIBRARY

Digitized by Google

Digitized by Google

Sci 163635

HARVARD
COLLEGE
LIBRARY

Digitized by Google

Digitized by Google

Digitized by Google

Sa 16.36.25

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION,

BULLETIN No. 1.

ENSILAGE.

APRIL, 1888.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

Digitized by Google

ENSILAGE.

The first investigation of ensilage made on the Agricultural College farm was in 1886. During the past year this work has been very much increased in amount and scope. Very few, to-day, doubt the economy of ensilage as food for farms tock, but there are a variety of opinions concerning the methods of production and storing of this valuable food. Many small or medium farmers are rejecting the silo, not for lack of faith in it but for a supposed lack of means. My object, in this work of investigation, was not, therefore, especially planned for the wealthy farmer, with large farm and stock, but rather for that larger class who till small areas, and whose plans must recognize the financial factor, the cost of equipment.

A few of the questions asked were:

1st. Are costly silos of masonry necessary?

2d. Can green crops be stored whole?

3d. Is rapid filling necessary?

4th. Is there any advantage to be gained by selecting the variety of corn planted?

1st. Experience demonstrates that a silo of forty to seventy tons capacity can be built in a section of almost any barn at a cost of one dollar for each ton, or for forty to seventy dollars. This pays for the lumber, the labor, and all materials used. On farms where there is an abundance of lumber, and stone for foundations. the *cash outlay* for a one hundred ton silo need not exceed $25.00 for materials, saw bill, etc.,

and 10.00 for labor, supposing the team work done by farm team,

or $35.00 for a one hundred ton silo. First cost of silo, then, need not deprive any farmer of the benefits of ensilage.

2d. The experience of the past two years, both on the College farm and among others who have tried the system, has clearly shown that corn may be stored whole in the silo, giving, in many respects, a better preserved ensilage than when cut into

Digitized by Google

inch or half inch lengths. My position on this point is precisely what it was one year ago, namely: To those that have power, whether horse or steam, and who do not object to having a few hundred dollars invested in extra machinery, I would say, cut your ensilage! it is more convenient to feed, it comes out of the silo with less labor, the extra cost in storing will be offset by the convenience in handling, *and, in case of rank growing corn*, of the Western or Southern varieties, by decreased waste in feeding; to those who have no conveniences for cutting and who are hesitating to invest in the needed machinery, I would most emphatically say, build a silo and fill it with whole corn, packing carefully, and you will have a first-class article well preserved, and if the corn is of medium growth little will be wasted in feeding; no farmer should hesitate, for a moment, if the case has resolved itself into a question of whole ensilage or no ensilage, in fact, I feel certain that, in many cases, even when a machine could be hired to come at the right time and cut the corn, it would prove unprofitably from the financial point of view alone.

3d. Rapid filling is not only unnecessary but it is objectionable, for two reasons: first, to the average farmer it means the hiring of considerable outside help, both of men and teams, and, second, I am satisfied that better ensilage, whether whole or cut, will result from slow filling than from rapid.

4th. The question as to whether there is an advantage in selecting seed for ensilage corn is one of great importance and one that has been too much neglected; there was a time, not wholly past either, when *bulk* and *weight* were the only measures of value that were supposed to apply to ensilage crops. *Tons per acres*, regardless of *feeding value per ton*, were regarded as the best indication. This is wrong, and to-day the most experienced users are finding that immature, watery varieties, though standing higher on the scale of *tons per acre* are really lower on the true scale of *feeding value in the manger.*

The general scope of our work for 1887 was as follows: To determine the most valuable variety of corn for our climate and locality; to compare the cost of production and feeding value of such varieties; to note the relation of crop composition to degree of maturity; to compare the relative cost of harvesting corn, both for cut and whole ensilage, and for the crib and fodder stack; to determine the relative exhaustion of the soil occasioned by the varieties experimented with.

Digitized by Google

As the work progressed other lines of inquiry presented themselves, many of which could not be worked out for lack of time and means.

Four varieties of corn were selected. One, a white Southern, or dent corn, widely sold as an ensilage corn; another, a dent variety, sent out two years ago by the Department of Agriculture, known as the "Pride of the North," originating in Minnesota; a third, known as the "Sanford" corn; and the fourth variety, a common twelve-rowed corn, producing a large growth, both of fodder and ears. This latter corn is a variety which, in ordinary corn years, will mature well for husking.

Five acres of land, in one field, were selected for the work. A part of the land was sod land, broken in the fall, and the remainder had been in winter rye and millet the previous year. The rows were so arranged as to give each experiment the same relative proportion of sod and old land. The field was divided into two parts and duplicate rows were arranged on each half; also, one-half was fall manured and the other half in the spring.

The following statement shows the cost of producing an acre of ensilage on this field:

	TOTAL FOR FIVE ACRES.	
Plowing,	$6.50	
Replowing in spring,	1.50	
		$8.00
Drawing and spreading manure (on north half) thirty-five loads,		7.50
Drawing manure into heap in winter (south half),	$6.50	
Moving manure from heap (south half),	2.70	
Drawing manure from yard (south half),	6.00	
		$15.20
Spreading,		1.50
Harrowing,		6.50
Marking for planting,		1.50
Planting,		2.40
Applying fertilizer,		.87
Total cost of labor up to the time seed was in the ground,		$43.47
Harrowing after corn was up (3 times over),	$1.65	
Cultivating,	6.07	

Digitized by Google

Hoeing by hand,	9.74	
		$17.46
Total labor from plowing to harvesting for 5 acres,		$60.93
Total from plowing to harvesting per acre,		12.19

The cost of harvesting varied with the yield per acre and the method of harvesting, and will, therefore, be given for individual acres rather than for the whole five.

One acre planted with the Southern corn, with the ensilage cut into three-fourths inch lengths, cost as follows:

Cutting and loading,	$5.56	
Drawing into barn,	4.68	
Cutting and packing,	11.97	
Cost of harvesting per acre,		$22.21
The yield was 20.45 tons, or a cost per ton of		1.08

With the Sanford corn the cost was:

Cutting and loading,	$3.76	
Drawing,	3.15	
Cutting and packing,	8.37	
Total for harvesting,		$15.28
Yield per acre 15.31, or cost per ton for harvesting,		1.00

With the Pride of the North the yield was 12.54 tons, and the cost of harvesting per ton, $1.24.

The Northern field gave us 16 tons, cost for harvesting, $1.00.

The rule for charging the cost of manure is not a definite one, and varies among various writers. Some charge the whole cost of manure applied, others one-half or one-third.

In my work I have followed a three years rotation and charge the total value of all manure used equally to the three crops, thus one-third of the total application stands charged to the ensilage. The following figures show the value of all manure and fertilizers used on the five acres:

31.7 cords farm yard manure at $3.00 per cord,	$95.10
1,000 lbs. fertilizer, at $1.90 per cwt.,	19.00
Total for five acres,	$114.10
Or per acre,	22.82

The interest on land is divided each year, as two crops are produced. Each is charged one-half interest on value of an acre

Digitized by Google

of land; the cost of seed is charged to each crop. These factors cover the whole cost of producing ensilage, from the turning of the first furrow to the weighting of the silo.

The following recapitulation gives this cost, both per acre and ton, of product:

Labor, up to harvest time, per acre,	$12.17
Labor harvesting,	22.21
Cost of manure, $22.82, (one-third charged to this crop),	7.61
Total per acre,	$41.99
Yield 20.45 tons; cost per ton,	$2.05
Add interest and value of seed used,	.16
Gives whole cost per ton of Southern corn ensilage as put into the silo,	$2.21

Apply the same summary to the Sanford corn and the cost complete becomes, $2.48.

With the Pride of the North it is $3.07, and with the Northern field corn, $2.40.

The following table will give a comparative statement of the yield and cost of the four varieties:

	Yield per acre in tons.	Cost per ton.
Southern corn,	20.45	$2.21
Sanford corn,	15.31	2.48
Northern field corn,	16.00	2.40
Pride of the North,	12.54	3.07

Here we have varieties of corn producing ensilage in varying quanties per acre and at varying prices, and the problem which the practical man desires solved is this: Is there any one variety better than the others?

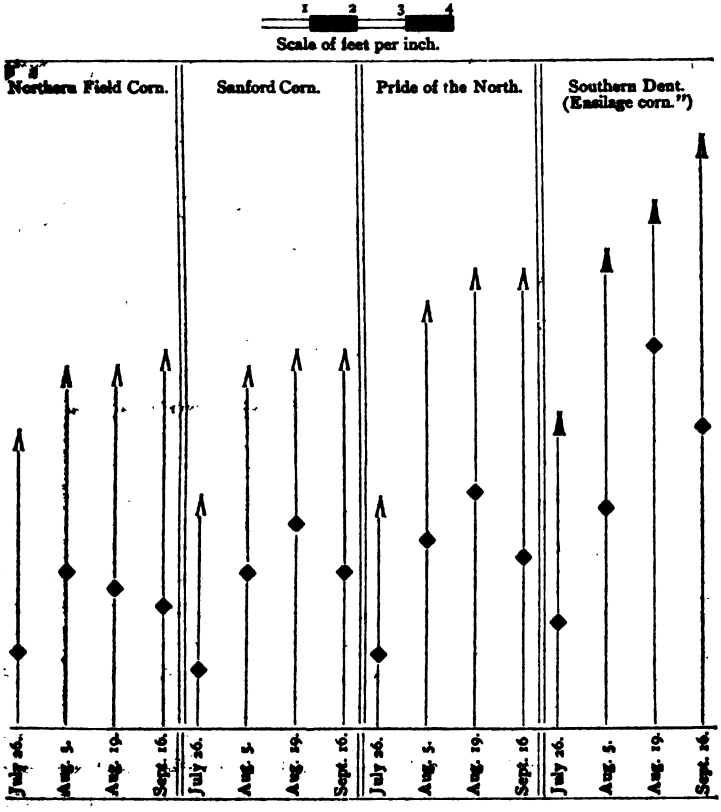
There is but one way to finally settle such a problem, and that by *feeding* the different kinds and noting the product, whether beef, milk, or butter. But alongside of this feeding it is of great value to know the chemical composition of the crop.

July 26 samples were taken from each variety of corn. Five average stalks were cut up, their weight, height and degree of development carefully ascertained and recorded; four stalks of each of these varieties were hung up in a dry attic to air dry, the other stalk was taken to the laboratory cut up and the per cent of water determined. The part not used in this water determination was dried and bottled for future analysis.

Digitized by Google

August 5 another set of samples were taken in the same way, and again, on each of the following dates, namely, August 19 and September 16. This gave samples of each variety at different dates, enabling a comparison of the varieties at the same date, and of the changes in development and composition at given intervals.

The following graphical table shows the height of the corn in feet at the intervals mentioued, as well as the weight per stalk in ounces, the whole length of vertical line representing feet on the scale of 1 inch equals 4 feet, or ¼ inch equals 1 foot, while the character (◆) represents the weight per stalk, in ounces, ⅛ inch in vertical height equals 4 ounces.



This shows that the ensilage corn did not reach its full development in height until September 16. The Pride of the

Digitized by Google

North attained its full height August 19, and the Northern Field and Sanford, Aug. 5.

In general the weight per stalk increased in about the same ratio as the height until August 19, while after that, and until September 16, in each variety there was a falling off in weight, caused, no doubt, by a loss of water in the stalks.

September 16 the height of the

Southern corn was	12	ft.,	weight per stalk,	47	ounces,
Pride of the North was	9½	ft.,	"	"	27.8	"
Sanford was	8	ft.,	"	"	27.6	"
Northern Field was	8	ft.,	"	"	22.4	"

The degree of maturity, as shown by the various external changes, such as tasseling, throwing out silk, blistering of kernel, kernel in boiling stage, and maturity of kernel, were all recorded, and in the following table are given the date at which these several stages were reached by each variety:

Kind of Corn.	Greatest		Date of				
	Height.	Weight.	Tasseling.	Silking.	Kernel Blister'g	Kernel full.	Kernel Matur'd
Southern,	Sept. 16	Aug. 19	Aug. 19	Aug. 19	Sept. 16	Sept. 25	
Northern Field,	Aug. 5	Aug. 5	July 26	Aug. 5	Aug. 5	Aug. 19	Sept. 16
Sanford,	Aug. 19	Aug. 19	Aug. 5	Aug. 19	Aug. 19	Sept. 16	Sept. 30
Pride of the North,	Aug. 19	Aug. 19	Aug. 5	Aug. 5	Aug. 5	Aug. 19	Sept. 30

It will be observed that in all but the Minnesota corn (Pride of the North) the time of maximum weight and "silking" were the same, hence, so far as *tons per acre* are concerned, the crop could have been cut at that time to the best advantage. The period between "silking" and "full" kernel, or when in the boiling stage, was as follows: Southern corn, thirty-seven days; Northern field corn, fourteen days; Sanford, twenty-eight days; Pride of the North, fourteen days.

The Pride of the North is a dent corn, which is but little behind the flint variety grown in this region, and it matures its seed very well in favorable seasons, the small yield is against it, however. The Northern flint lead the varieties in earliness and, as will be seen by the yield per acre, was not exceeded by any except the Southern corn.

It appears that while the Sanford was from ten to fourteen days later than the Northern field, it was well matured by September 15, and produced practically the same weight per acre at nearly the same cost per ton.

Digitized by Google

The samples taken September 16 were divided into stalk, ear, husk, and leaves, and weighed, with the results given below:

Variety.	Stalk.	Ear.	Husk.	Leaves.	Total.	Ratio of leaves to stalk.	Ratio of ear to total wei't.
	oz.	oz.	oz.	oz.	oz.		
Southern,	15⅛	6⅜	4⅜	8	34⅜	1 : 1.9	1 : 5.2
Northern Field,	9¼	7¾	1¼	4½	22¾	1 : 2.2	1 : 2.9
Sanford,	11	2½	2	4½	19¾	1 : 2.7	1 : 7.8
Pride of the North,	9	7	3¼	4½	23¾	1 : 2	1 : 3.4

This table is not based upon enough weighings to be taken as a standard, and is, in a measure, misleading, for example, the Southern corn appears more leafy than any other variety, but the thick base of the leaves encasing the stalk are much longer in this variety, and being very thick bring up the weight of the leaves. This may be an advantage, or the reverse, according as this part of the leaf is richer or poorer in nutriment, a question which I find no information on. Chemical analysis would show this, but this line of inquiry was, from necessity, left for future investigation.

In the case of the Sanford corn, I am of the opinion that the proportion between the total weight and the weight of ear is too small to represent a true average.

In the case of the Northern field and Pride of the North the ratio of ear to total weight is very nearly correct as was shown by husking a part of the corn later.

CHEMICAL COMPOSITION OF CROPS.

The samples taken at the date above mentioned were analysed by Dr. Burleigh, with the results given below:

Date.	Southern.		Northern Field.		Sanford.		Pride of North.	
	Water.	Dry substance.	Water.	Dry substance.	Water.	Dry substance.	Water.	Dry substance.
July 26,	91.25	8.75	87.75	12.25	90.85	9.15	90.65	9.35
Aug. 5,	89.18	10.82	86.10	13.90	86.79	13.21	87.56	12.44
Aug. 19,	84.95	15.05	81.45	18 55	86.75	13.25	82.25	17.75
Sept. 16,	75.40	24.60	72.40	27.60	77.20	22.80	70.45	29.55

The increase of dry substance, which is the only part of value as food, in the ordinary acceptation of the word food, is exhibited in the following tabular form:

Per centage increase of dry substance in growing corn.

Variety.	From July 26 to Sept. 16.	From Aug. 19 to Sept. 16.
Southern,	181 per cent.	63.4 per cent.
Northern field corn,	125 per cent.	48.8 per cent.
Sanford,	149 per cent.	72.0 per cent.
Pride of the North,	216 per cent.	66.4 per cent.

Digitized by Google

These figures must be taken in connection with the last table, as they show the per centage of increase and not the absolute gain, thus the gain on the Northern field came from July 26 to September 6 is 125, but on July 26 the Northern field corn had 12¼ per cent of dry substance, while the Southern corn had only 8.75.

Comparing the dry substance in one hundred pounds of corn at the several dates and we shall find the following to be true:

Gain of dry substance from	July 26 to Sept. 16.	Aug. 19 to Sept. 16.
Southern,	15.85 lbs.	9.55 lbs.
Northern field,	15.35 lbs.	9.05 lbs.
Sanford,	13.65 lbs.	9.55 lbs.
Pride of the North,	20.20 lbs.	11.80 lbs.

So that while the per cent. of increase varied widely the actual gain per hundred pounds was nearly identical in three of the varieties.

The following table shows the complete analyses of the four varieties, as sampled September 16:

	Water.	Dry substance.	Albumenoids.	Nitrogen free extract.	Ether extract.	Fibre.	Ash.	Ash contain'd	
								Phosphoric acid.	Potash.
Southern,	75.40	24.60	2.36	14.58	0.58	5.95	1.13	.0269	.0917
Northern Field,	72.40	27.60	2.65	17.17	1.30	4.79	1.69		
Sanford,	77.20	22.80	2.11	13.85	1.08	4.81	.93		
Pride of the North,	70.45	29.55	3.25	16.90	1.59	6.04	1.77	.0888	.0342

From these figures we may compute the total amount of each constituent produced per acre, obtaining the following:

	Dry substance.	Albumenoids.	Nitrogen free ext'ct.	Ether extract.	Fibre.	Ash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Southern,	10060	965	5961	236	2435	463
Northern Field,	8832	848	5497	415	1532	540
Sanford,	6980	646	4247	330	1470	286
Pride of the North,	7411	815	4239	397	1516	444

If we accept the chemical composition as a true basis of value the twelve and one-half tons of Pride of the North would be more valuable than the fifteen and one-third tons of Sanford, and nearly as valuable as the sixteen tons of Northern field corn, but no test that stops short of the feeding barn can be decisive, and we will, therefore, defer all discussion of this point until a subsequent "Bulletin on Feeding."

Digitized by Google

It is to be noted that the Southern corn did produce more dry substance per acre than any other variety; it should be remembered, however, that while the Southern corn produced twenty-seven per cent. more gross weight as harvested it produced but fourteen per cent. more dry substance than the Northern field corn, and reducing the cost per hundred pounds of dry substance into a comparable form we find it to be $0.448 for the Southern, and $0.434 for the Northern.

Ensilage shrinks in the silo, so that the number of tons available for feeding is less than the total amount harvested.

Last year the shrinkage for whole corn ensilage was twenty per cent for Southern corn.

This year the Southern corn cut, not whole, shrunk 16.5 per cent., the Sanford cut 5.5 per cent., and the Northern, put in whole, 23 per cent.

COST OF FILLING, WHOLE OR CUT.

Our ensilage corn in 1886 was an average distance of forty rods from the silo, and in 1887 it was fifty rods away, so that the cost of filling is comparable. In 1886 the Southern corn was put in whole, the yield was twenty-two tons per acre, and the cost of harvesting was fifty-five cents per ton. In 1887 the cost was $1 08, the yield per acre being twenty and one-half tons. This extra fifty-three cents represents the additional cost for cutting.

In 1886 the cost per ton of harvesting the field corn ensilage was sixty-one cents when put in whole, while in 1887 the cost, when run through the ensilage cutter, was one dollar.

Or if we confine the comparison to the past year's work we have the cost of harvesting a field of ensilage not included in the experiments upon which this Bulletin is based. This field is two hundred rods from the barn and would, therefore, be at a disadvantage as compared with the field averaging but fifty rods distant.

The cost of harvesting the *whole* ensilage on the field two hundred rods from silo was 60.7 cents per ton. The cost of harvesting the *cut* ensilage on field fifty rods distant was $1.00 per ton.

The yield in each case being practically alike, had the former field been but fifty rods away I believe the cost could have been reduced from 60.7 cents as low as 50 or 55 cents. In general we may say that, so far as our experience goes, it will cost

Digitized by Google

from forty to fifty cents extra per ton to run it through the cutter, and a part of this comes from the fact that more teams and men are needed, and the wasted time becomes considerably greater, even with the most careful planning.

THICK OR THIN PLANTING.

A part of our plan covered the point of seeding, and while the results obtained are not in accord with the views of many careful and intelligent ensilage users they are, nevertheless, the results that the scales gave and, while not conclusive, are certainly better than an unsupported opinion.

One question intimately connected with this cannot be discussed in this Bulletin for lack of date. I refer to the effect of thick planting upon *quality* of product.

The Sanford corn was planted as follows: Four rows on south half of field, seeded thin (sixteen quarts per acre). Duplicate rows were planted on the north half of field, but two of these were seeded thin, (sixteen quarts), and the other two thick, (thirty-two quarts per acre).

The yield, computed per acre, was as follows:

South half of field, thin seeding, 13.44 tons.
North half of field, thin seeding, 15.72 tons.
North half of field, thick seeding, 18.67 tons.

The Pride of the North was also planted in two ways, the north half seeded at the rate of sixteen quarts per acre, and the south half thirty-two quarts per acre. The yield was, for the thin planting, 11.52 tons, and for the thick planting, 13.51 tons.

The conclusion, so far as any can be drawn from this statement, must be that thick seeding will give greater yields per acre than thin, but further investigation may show that the quality is inferior.

The silo is one of the few additions to our agriculture that is applicable to men of limited means, and is, at the same time, within their reach.

Agricultural machinery, or thoroughbred stock, though greatly needed by all, are often beyond the means of the farmer tilling small areas, the expense being out of proportion to the income. But a silo is just as available and just as valuable to the farmer keeping five head of cattle as it is to the possessor of a hundred, hence, the importance of thoroughly establishing a ra-

Digitized by Google

tional and economical system of producing and storing this kind of food.

The following directions for establishing the system upon either small or large farms may aid those wish to commence the present year. The capacity of the silo must first be determined, and this is dependent upon the number of cattle to be fed. For our climate we must count upon barn feeding for two hundred days, and at fifty pounds of ensilage per day we shall need five tons per animal; this amount will be sufficient for a full sized cow or ox. Young cattle need less, but with the shrinkage and waste five tons is a sufficiently close estimate. For twenty cattle, therefore, one hundred tons are needed. Having decided on the amount needed, the question arises, how great a space is needed to hold this amount. No definite answer can be given to this, as the space required per ton varies with the size of silo and the depth. Fifty cubic feet will contain rather more than a ton in siloes of seventy to one hundred tons capacity, so that our silo to hold one hundred tons might be 15x15 feet and thirty feet high, the extra space being necessary, as it is impossible to fill a silo so as to have it more than three-fourths full when settled. A better shape for a one hundred ton silo would be 20x20 feet and sixteen feet high; the dimension for a fifty ton silo might be 12x15x16 feet; a twenty-five ton silo, 12x12x12 feet; a twenty ton silo, 10x10x12 feet.

HOW TO CONSTRUCT.

If economy is to be practiced, select a section or joint in the barn, remove floors, and if there is a barn cellar place sills on the bottom of this and set 2x8 scantling vertically, bringing the inside edges even with the sills of the barn. The bottom may or may not be cemented, according as the ground is wet or dry. If to be cemented, three casks of cement and an equal amount of sharp sand or gravel will cover a bottom 16x16 and turn up on the sides two feet, which will give a tight silo. Common spruce or hemlock boards, square edged and planed on one side, are the best for boarding the inside of the silo; these are to be put on in two courses, breaking joints, and if thoroughly nailed will give a tight pit. No tongueing or matching is needed. Tarred paper may be put between the boarding, if desired, but I doubt if it is of great utility. At some point, most easily accessible, an opening, extending nearly the height

Digitized by Google

of the silo, must be made to put in the corn and take out the ensilage. The courses of boards should be cut shorter than the opening to allow loose boards to be set in, lapping on the door studding and making an air-tight joint.

For all this work medium lumber is good enough, and a very limited amount of mechanical skill and a few tools, which all farms should have, will enable most farmers to build their own silo. A few iron rods, one-half inch in diameter, may be necessary to prevent spreading by side pressure, but this will depend upon the strength of the original frame of the barn.

Narrow boards, from five to eight inches wide, are better than wide ones, as they are not likely to swell and split. Eight penny nails for the first boarding and twelve penny for the second course will hold the boards in place.

A silo, constructed as above outlined, will cost from fifty cents to one dollar for each ton of its capacity, according as all materials, including lumber and stone, are charged, or only labor and nails, rods and cement.

RAISING THE CROPS.

Sod land fall plowed and, if possible, fall manured, will produce the best results generally, but this point is not of great imtance. The location of the field is to be considered. Land that is near the silo is very desirable. We have only to remember that an acre will produce from twelve to twenty loads which must be conveyed to the barn to appreciate the importance of nearness. The land should be well manured with from ten to fifteen ox loads of good farm yard manure and, in addition to this, it will pay to apply two hundred pounds of some concentrated fertilizer in or on the drills or hills. A fertilizer containing a good per cent. of potash is desirable, and this may be secured in the following mixture of chemicals which may be bought from any wholesale fertilizer manufacturer:

Dissolved bone black,	250 lbs.,	cost about $10.00.
Muriate of potash,	200 lbs.,	
Sulphate of ammonia,	50 lbs.,	
	500 lbs.	

Such a fertilizer would give the following analysis:

		Average analysis of ten prepared fertilizers.
Nitrogen,	2 per cent.	3 per cent.
Soluble phosphoric acid,	8 per cent.	11¾ per cent.
Potash,	10 per cent.	9¼ per cent.

Digitized by Google

I have given the average of ten of the best fertilizers to show wherein they differ from the above mixture.

The quantity of land needed will depend upon the capacity of the silo. On average land from twelve to sixteen tons may be considered an average yield per acre.

No unvarying rule can be given for the selection of the variety of corn best adapted for ensilage, the climate of the given place must largely determine this, but my rule has been to select some variety of corn that will, in average years, mature sufficiently to bring the kernel into the "roasting stage," that is, so far perfected that the interior of the kernel is past the period of milky consistency, and, if a flint variety, is well towards the time of "glazing," or "specking," externally. By this rule a corn that would be abundantly early for southern New Hampshire might not develop sufficiently for Grafton county, hence, each locality must select corn adapted to its own wants.

I cannot advise any one to buy the Western or Southern corn, which, in the best of seasons, does not more than reach the period when its kernel is filled with a watery fluid, such corn contains too much water and too little nutriment, or dry substance. It is by no means a bad practice to plant precisely the same variety of corn as is used for planting fields intended to be husked, for when this practice is followed the amount put in the silo may be varied and the remainder, whatever the amount, may be stooked for husking.

The quantity of seed per acre must be left largely to the judgment and experience of the farmer. Our practice on the College farm has been to plant in rows three feet two inches apart, using twelve quarts of Northern seed corn per acre, when intended for husking, and sixteen quarts of seed when intended for the silo. With the Southern corn thirty-two quarts per acre is used, and with the Sanford corn sixteen quarts. These quantities have given us satisfactory results. Many others, however, use less seed and a few use more.

The cultivation of the crop is a matter of some importance, for the cost of the product depends largely upon the amount of labor expended. In many cases, where the land is comparatively free from stones and strawy manure, a light smoothing harrow may be profitably run over the land just as the corn is pricking through the soil, and again when two or three inches high. After this the cultivator or horse hoe should be run often and

Digitized by Google

until the corn is two feet high; where there is little "witch grass" (also known as Couch grass, Scotch grass, etc., etc.,) on hand hoeing is necessary, but with an abundance of this troublesome grass once through with the hand hoe is necessary.

HARVESTING.

Harvesting should commence in season to secure most of the crop before the first hard frost; no man can tell when this will be, and so no rule can be given. A light frost does not materially injure ensilage, but a heavy one probably works injury, especially if the corn is allowed to stand long.

The method of harvesting depends upon the way in which the ensilage is to be stored. When there is lack of machinery for cutting, or when it is desired to try ensilage one year before investing in a full outfit, packing whole will give a nice quality of ensilage and will necessitate no extra outlay in harvesting, the ordinary help on the farm and the usual team will fill the silo fast enough, in fact, it may sometimes be necessary to wait for the temperature in the silo to rise, for I am convinced that it should be as high as 130° each day before a new lot is added. This method of whole filling is so simple, so entirely within the reach of all, and so satisfactory when practiced that I am forced to say, that were I to provide a silo on a farm of my own I should most certainly plant a variety of Northern corn, capable of producing twelve to fifteen tons of well matured corn per acre, and should pack it whole, allowing the temperature to keep as near 140° as possible while being packed.

There is another advantage in starting with whole ensilage, even if it proves unsatisfactory the first year, the cutter and power can be secured later for the second year, and there is nothing wasted, no outfit to throw aside, every dollar invested for the whole ensilage equipment is needed when the change is made, hence, there is no risk. On the other hand, if the whole ensilage does give satisfaction, then the extra outlay for machinery and the extra cost of filling is avoided.

In this I have in mind those farmers who desire to store from twenty to seventy-five tons of this food, rather than the men wishing for hundreds of tons, and as the former class are a hundred times more numerous than the latter, and also more seriously need the advantages which ensilage bring, I think I am justified in planning and executing the experiments especially from their point of view.

Digitized by Google

The first year our silo was weighted with six tons of sand; this had to be thrown up to the top and again thrown down. The question arose, "Is it necessary to weight?" The past year no weight was put on, only loose straw was thrown on to cover the last corn. The result was entirely satisfactory, there being no waste worth mentioning. On a small silo, especially if it was not to be opened for use until midwinter, or until December 20 even, I should advise moderate weighting with muck or sand, the same to be used as an absorbant after its removal from the silo.

The discussion of the relative value of the ensilage as compared with hay and dry corn fodder will be undertaken in a later Bulletin, and in conclusion let me add, that, in my opinion, every farmer in our State to-day should carefully investigate the merits of preserved green food for his stock,. So far as my experience has taught me anything in this connection, it has been that the cost of keeping stock may be reduced from one-third to one-half by a judicious use of ensilage. The truth of this each farmer must demonstrate for himself, and it can be done, or commenced, this year as well as next. The experiment need not be costly, the results may be of great value.

G. H. WHITCHER, *Director.*

Hanover, N. H.

NOTE.—We are now preparing a list of names to whom all the Bulletins of the Station will be sent free, and we hope all who desire to become receivers will send their addresses on a postal card, and also the name of any other farmers in their vicinity.

G. H. WHITCHER, *Director,*
New Hampshire Experiment Station, Hanover, N. H.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION,

HANOVER, N. H.,

To Farm House,
University of Nebraska

BULLETIN NO. 2.

FEEDING EXPERIMENTS.

JUNE, 1888.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

Digitized by Google

The prime object in planning the feeding experiments recorded in this Bulletin was to determine as far as possible the actual feeding value of the ensilage produced from the different varieties of corn described in Bulletin No. 1, and incidentally to note the cost of a quart of milk or a pound of butter with the various rations used.

The animals experimented on were a mixed herd of young and mature cows in various stages of lactation, from fresh in milk to six months after parturition. Half of the herd had been bought from farmers and were native cows, there were four heifers with their first calves, and the remainder were thoroughbred Shorthorns. Taking all together they were a fair lot of cows, weighing at beginning of experiment an average of 943½ pounds.

The kinds of fodder and grain used were corn fodder or stover, bean vines, mixed hay containing a large proportion of alsike and red clover, millet cut when seed was fully formed, mixed grain consisting of ninety pounds of northern corn ground together with the cob, and twenty-five pounds of oats. gluten meal from the Chicago Glucose Works, buckwheat ground with hulls not separated, and clear corn meal ground from northern corn.

Lack of means and help prevented the analysis of part of the materials used, but the best average results of analyses of other years was taken as a guide to the composition of the rations used. The ensilage was analyzed, giving the following results, as taken from Bulletin No. 1 :

	Water.	Dry substance.	Albumenoids.	Nitrogen free extract	Ether extract.	Fibre.	Ash.	Ash contain'd	
								Phosphoric acid.	Potash.
Southern,	75.40	24.90	2.36	14.58	0.58	5.95	1.13	.0269	.0917
Northern Field,	72.40	27.60	2.65	17.17	1.30	4.79	1.69		
Sanford,	77.20	22.80	2.11	13.85	1.08	4.81	.93		
Pride of the North,	70.45	29.55	3.25	16.90	1.59	6.04	1.77	.0888	.0342
Samples taken:									
Dec. 7, from silo, Sanford,	69.76	30.24	3.09	18.82	1.65	5.32	1.36	.0556	.1171
Dec. 15, " Southern,	78.8	21.2	2.04	10.54	1 37	5.89	1.33	.0484	.1093
1886, Northern Field Corn,	70.55	29.45	2.65	18.84	.90	6.00	1.05		

Digitized by Google

The northern field corn ensilage was not analyzed after it was put in the silo, but from the analyses of last year I have placed in the table figures that will not vary much from the true analysis.

The cost per ton as harvested was as follows:*

Southern corn,	$2.21,	shrinkage in silo		16.5%
Sanford,	2.48	"	"	5.5%
Northern field,	2.40	"	"	23.%

The shrinkage of the Northern field corn is excessive, partly due to freezing to side of silo, and partly to a defective bottom of material left over from last year's filling; as nearly as could be estimated these accidental losses would reduce the actual shrinkage to 20%.

The actual cost then per ton as fed out would be as follows: Southern, $2.64; Sanford, $2.62; Northern, $3.00.

The price per ton for grains as figured from the market price of last winter was:

Corn and oats (mixed grain),	$26.00 per ton.
Gluten meal,	26.00 "
Corn and cob meal,	20 00 "
Buckwheat,	20.00 "
Corn fodder and bean vines,	5.00 "
Mixed hay,	8.00 "
Millet,	5.00 "

I have based the price of hay on the market value here in the barn, choice hay selling for $9.00, but this being the first year's crop was of less value on account of the old stubble which it contained. The corn fodder, millet and bean vines I have rated at $5.00, which is slightly more than they would sell for but is very close to their actual feeding value as compared with hay at the above mentioned price. With these figures as a basis we are in position to determine the cost of milk and butter with our own herd and under our own conditions, and also to note how a change of food affects the cost of the product.

The silo was opened in November and the whole herd were accustomed to the ensilage before the experiments were started.

*See method of determining cost, Bulletin No. 1, p. 3–5.

Digitized by Google

Dec. 6th the herd was put on the following rations per head: Sanford ensilage, 50 lbs.; mixed hay (largely clover), 5 lbs.; bean vines, 5 lbs.; mixed grain, 1¼ lbs.

The ration was the same as had been fed for some time previous, and was continued until the 12th, when the Sanford ensilage was all fed, and the next in order was Southern corn. In each case the corn was cut when the silo was filled.

Dec. 12, the ration was modified by substituting 50 pounds of the Southern in place of the 50 pounds of Sanford ensilage. No other part of the ration was changed, hence any considerable change must be due to a difference in the feeding value of the two kinds of ensilage. After feeding this ration for seven days it was decided to increase the grain ration and accordingly from the 19th to the 26th four pounds of mixed grain was fed to each animal instead of the 1¼ pounds previously fed. From the 26th to January 8th this ration was still further enriched by the addition of two pounds of ground buckwheat, and from Jan. 9–13 the grain ration consisted of two pounds of clear corn and cob (no oats being mixed with these) and three pounds of gluten meal. At this point the Southern ensilage was used up, and the Northern field corn came next. This was put in whole and was full of well matured ears which had kept perfectly and were as bright as when put in.

The milk of ten of the cows was weighed and recorded morning and night as was the total milk for the herd, and in the following table I have arranged the average daily product of each of these ten as well as the total for the herd for periods of seven days, and in the same table is shown the daily ration per cow and its cost as well as the amount of milk required to make a pound of butter, and also the cost of a quart of milk and a pound of butter.

I have given the cost per quart of milk for the best cow and for the poorest; also the average cost for the ten cows whose milk was weighed daily, and the average cost of the total product. It must be remembered that this last is affected by the fact that several or the cows had been long in milk, and consequently the cost per quart was higher than would have been the case with many winter herds, but taken all together the results would represent a very fair yearly average for the entire num-

Digitized by Google

ber. These results may therefore be taken as representative figures for cows under ordinary conditions.

In the cuts given I have represented the results contained in Table A in such a way that it is possible to see at a glance the leading features of the results therein recorded. A word in explanation of cuts 1 and 2 may be necessary. The first column shows the number of the cow and corresponds with the first column in Table A. The second column shows the scale of pounds and from this it is possible to determine the average daily product of any cow for any period. The figures from one to twenty-one across the top show the periods and correspond with the top line of figures in Table A. The curved lines running across the cut show the average product of milk for each cow and for the whole herd. The dotted lines running parallel to columns one and two represent the periods and are of use in determining how much milk was given at any definite time. For example suppose we wish to know how much milk cow No. 17 gave daily during the 8th period. Follow the curved line marked 17 in first column out to the point where it crosses the dotted line representing Period 8 (this point I have marked a). Now this point is opposite 7.4 in column second, showing that No. 17 during Period 8 averaged 7.4 lbs of milk daily. Any other yield for any period may be determined in the same way. Taken as a whole the curved lines by their upward or downward variation indicate respectively an increase or a decrease of daily milk product. Hence a general upward variation would indicate that for some reason, most probably a change of food, the cows were giving more milk. A gradual downward tendency might indicate a natural shrinkage as time elapsed. But a sudden downward variation would most probably show a less efficient ration. With these points in mind a study of Cut 1 and Table A may show something of value in feeding for milk.

Commencing with the first period there is a substantial and very uniform shrinkage, as shown not only by the individual averages (Cut 1, Sec. 1 and 2) but also by the total yield, Sec. 3. This shrinkage, amounting to from five to twenty per cent, can only be traced to one cause, namely, the substitution of fifty pounds of Southern corn ensilage for fifty pounds of Sanford ensilage. So general and so large a falling off cannot be at-

Digitized by Google

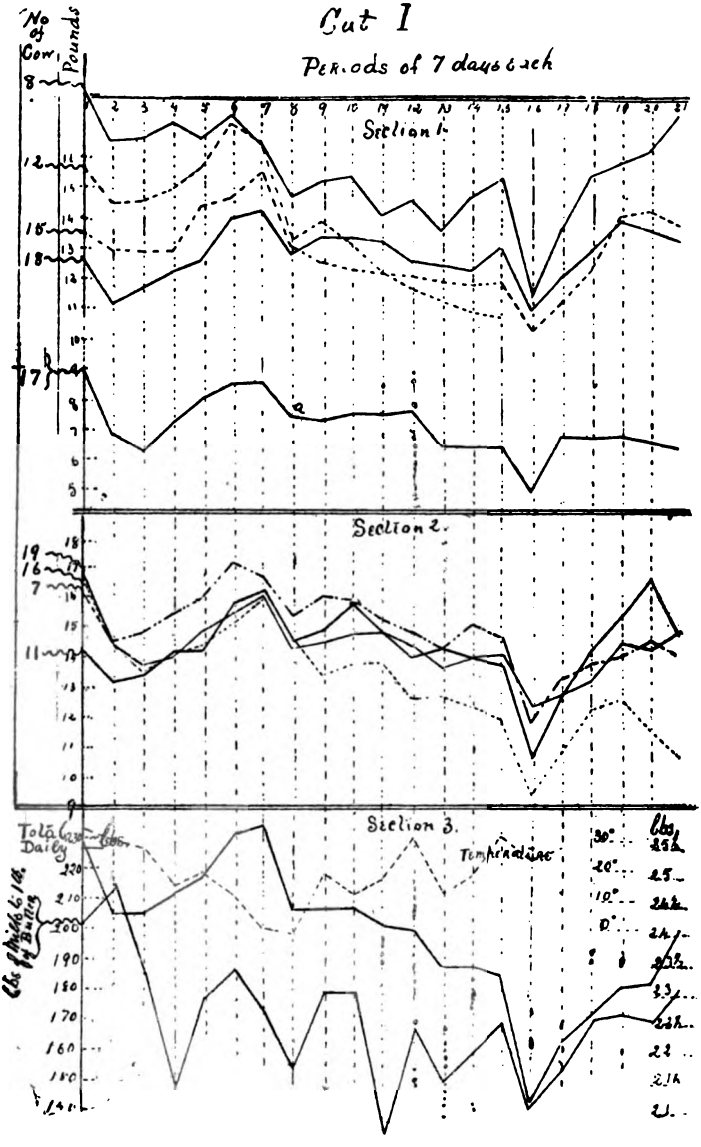
Period.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of cow.	Dec. 1887, 6–11.	12–18.	19–25.	26 to Jan. 1, 1888.	2–8.	9–13.	14–22.	23–29.	30 to Feb. 5	6–12.	13–19.	20–26.	27 to March 4.	5–11.	12–18.	19–25.	26 to April 1.	2–8.	9–15.	16–22.	23–29.	30 to May 6.
2	13.75	12.39	12.75	12.64	13.20	14.05	14.31	13.21	13.25	13.10	13.00	12.46	12.25	12.05	12.00	10.5	11.35	12.68	13.1	13.85	14.71	
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22.00	20.68	21.02	21.28	19.21	18.78	19.82	20.00	20.43	21.21	21.07
7	16.21	14.50	14.75	15.36	15.93	17.10	16.61	15 25	15.9	13.80	15.2	14.75	14.2	14.96	14.53	11.7	13.1	13.6	13.9	14.4	13.8	13.6
8	18.37	16.57	16.61	17.18	16.64	17.45	16.39	14.75	15.25	15.39	14.1	14.60	13.6	14.68	15.3	11 4	13.6	15.4	15.8	16.2	17.4	18.8
11	14.12	13.11	13.39	14 14	14.18	15 70	16.17	15.39	14.8	15.60	14.75	14.25	13.46	13.9	14.00	12.2	12.6	13.1	14.3	14.1	14 7	14.4
12	15.75	14.50	14.61	15.07	15.75	17 20	16.50	13.30	13.95	13.20	12.18	11.7	11.3	10.95	10.65	7.2	7.00	6.6	8.2	7.00		
15	13.58	12.89	12.86	12.86	14.43	14.75	15.56	13.10	12.5	12.30	12 2	12.1	11.9	11.8	11.9	10.2	11.2	12.3	14.00	14.2	13.7	
*16	16.58	14.32	13.53	14.14	14.39	15.10	15.97	14.50	13.4	13.80	13.82	12.6	12.7	12.4	12.00	9.43	10.75	12.25	12.6	11.5	10.6	
*17	9.04	8 8	6.32	7.21	8.00	8.55	8.58	7.40	7.32	7.53	7.46	7.6	6.4	6.4	6.4	4.9	6.7	6.7	6.8	6.6	6.4	
*18	12.75	11.21	11 71	12.25	12.61	14.05	14.25	12.80	13 4	13.40	13.25	12.6	12.46	12.3	13.00	10.9	12.00	12.9	13.9	13.6	13.2	
*19	16.75	14.36	13.71	14 00	14.82	11.05	15.97	14.32	14.53	14.75	14.82	14 00	14.25	14.00	13.78	10.6	12.6	14.2	15.4	16.6	14.7	
Total milk daily, herd	229.2	204.86	205.57	212.00	217.54	231.45	234.50	206.18	206.53	207.00	201.5	200.00	187.63	189.1	184.32	144.22	163.4	172.00	181.00	182.6	200.7	
Cost of milk, per quart. To produce 1 lb. butter.	Cents 23.7	Cents 27.45	Cents 28.13	Cents 28.35	Cents 30.00	Cents 26.9	Cents 19.7	Cents 23.7	Cents 27.3	Cents 24.1	Cents 22.3	Cents 24.9	Cents 24.8	Cents 25.8	Cents 25.8	Cents 23.4	Cents 27.6	Cents 34.9	Cents 29.4			
Highest.	2.63	3.58	5.03	5.05	4.64	4.02	3.12	3.91	3.95	3.84	3.92	3.80	4.53	4.53	4.53	4.73	4.32	5.7	5.00			
Lowest.	1.32	1.47	1.94	2.13	2.23	1.97	1.61	1.88	1.82	1.83	1.91	1.31	1.40	1.38	1.36	1.20	1.54	1.90	1.72			
Av. for 10 cows.	1.655	1.864	2.473	2.709	2.687	2.365	1.786	2.236	2.15	2.15	2.21	2.28	2.36	2.34	2.34	2.28	2.60	3.18	2.66			
Av. for herd.	2.02	2.27	2.98	3.27	3.25	2.83	2.17	2.58	2.56	2.57	2.64	2.39	2.54	2.53	2.58	2.79	2.90	3.66	3.25			
Average lbs. of milk to 1 lb. butter.	Lbs 25.25	Lbs 25.9	Lbs 24.46	Lbs 22.5	Lbs 24.0	Lbs 24.5	Lbs 23.8	Lbs 22.8	Lbs 24.1	Lbs 24.13	Lbs 21.7	Lbs 23.5	Lbs 22.6	Lbs 23.7	Lbs 23.6	Lbs 22.1	Lbs 22.8	Lbs 23.6	Lbs 23.7	Lbs 23.6	Lbs 24.1	
Daily Ration. Ensil. Sanford.	50																					
Ensil. Southern.		50	50	50	50	50																
Ensil. Northern.							50	50	50	50	50	50	50	50	50		50					
Dry fodder. Mixed hay, (largely clover).	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5			
Dry fodder. Herdsgrass hay.																†10.5						
Dry fodder. Corn fodder.					6	6	6	6										8	8			
Dry fodder. Bean vines.	5	5	5	5																		
Dry fodder. Millet.									6	6	6	6	6	6	6	6	6	6	6			
Grain. Mixed grain.	1¼	1¼	4	4	4			2	2	2	2	2	2	2	2	2	2	9½	8			
Grain. Buckwheat.				2	2																	
Grain. Gluten.						3	¾															
Grain. Corn & cob meal.						2	½															
Cost of daily ration per head.	$ 0.11⅓	$ 0.11⅓	$ 0.15	$ 0.17	$ 0.17⅓	$ 0.16	$ 0.12½	$ 0.13½	$ 0.13⅛	$ 0.13½	$ 0.13¼	$ 0.13⅛	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.10¾	$ 0.13½	$ 0.17¾	$ 0.16			

*Heifers with first calves.

TABLE A.

†Cows were fed all the hay they would eat and weight noted.

Digitized by Google



Digitized by Google

tributed to accidental causes, and as the nature of the food was the same, there being no radical change, one succulent food being exchanged for another equally succulent, it cannot be said that the digestive organs were in any way overtaxed. Neither was the food less palatable for it was perfectly preserved and greedily eaten. There is no escape from the conclusion that the Southern corn ensilage was less valuable in the feeding barn as its analysis shows it to have been in the laboratory. The next step was to increase the grain ration by feeding four pounds of mixed grain instead of 1¼. Looking at our curved lines in Cut 1 from *period two to three* it is found that in four of the individual records a small shrinkage still manifests itself. In five cases there is a small increase in product while the total milk, Sec. 3, remains almost constant, there being but 7-10 of a pound increase daily on the milk of the entire herd. There is reason for believing that this ration, had it been fed at the commencement of Period 2, would have kept up the flow or at least would have come very near to it, but from the bottom of Table A it is seen that the ration for the third period cost fifteen cents daily for each cow while for Period 1 it cost but 11⅓ cents.

During the *fourth period* a still further addition was made of two pounds of ground buckwheat, increasing the cost of the ration to seventeen cents per head daily. The effect of this was to increase the daily yield of eight of the cows, as shown by the upward direction of the lines in the cut, one, No. 15, remaining stationary, while the total milk increased 3⅓%

Period five was like four, except that six pounds of corn fodder were fed in place of five pounds of bean vines, but as the feeding value of the two is nearly identical this variation was probably without effect. All of the cows, except No. 8, increased in quantity during this period, and by the indication of the lines in the cut it appears that the increase was nearly identical with the previous period.

Period sixth. A radical change was made in the grain fed, gluten meal three pounds and corn and cob meal two pounds being used, the ensilage and dry fodder remaining the same. The result was a decided increase, the total yield coming up to and slightly surpassing the yield at the commencement of the work. This closes the work with Southern ensilage, and gives

Digitized by Google

us data for determining the relative economy of the Sanford and Southern varieties of corn. The first period is the closing part of nearly a month of almost identical feeding, during which the individual record was kept, but as the complete record of total milk was not made the experiment is considered to have commenced at the date indicated in Table A, and although the figures for the Sanford feeding appear for a short period they are really the last seven of a twenty-one days period, during which time the averages were very close to those given.

TABLE B.

Period (7 days each),	1	2	3	4	5	6
	lbs	lbs	lbs	lbs	lbs	lbs
Milk produced,	1604.4.	1434.	1439.	1484.	1512.8	1620.
Cost of food,	$15.06	$15.06	$19.95	$22.61	$23.00	$21.28
	cts.	cts.	cts.	cts.	cts.	cts.
Cost per qt. of milk,	2.02	2.27	2.98	3.27	3.25	2.83

Table B is intended to show the actual amount of milk produced by the herd for each period, also the value of the food consumed in producing the same and the cost of food per quart of milk.

This table shows that on account of the change from Sanford to Southern ensilage it became necessary to increase the grain ration from 1¼ lbs. of mixed grain, to six pounds of mixed grain and buckwheat before the yield was restored to its former amount, and in so doing the cost of a quart of milk was increased from 2.02 cents to 3¼ cents. Or if we take the cost of the milk required to make a pound of butter it is increased from 23.7 cents to 30 cents, an increase of 26½%.

During the sixth period the grain was changed, reducing the cost of the daily ration 1⅓ cents, but in no way decreasing its efficiency. The result of this change was to produce milk at 2.83 cents per quart, and butter at 26.9 cents, a cost still 13½% above the cost while the Sanford corn ensilage was being fed. These figures show a most decided difference in favor of an ensilage produced from mature corn with a good proportion of ears that were well past the boiling stage, or as is commonly said "past the milk."

The next feeding was with Northern corn ensilage, stored whole. Unfortunately an important step in the investigation

Digitized by Google

was omitted at this point which prevents a direct comparison of the Southern corn ensilage and the Northern. There should have been two or three periods of feeding and the same grain ration as that used in Period 6. Instead of this the grain ration was reduced to a very small amount, 1¼ lbs of gluten and corn and cob meal. With this reduction the yield fell off in a few cases, but in the majority of the records it increased, reach- a maximum during the seventh period in the total yield. The new ration gave an increase of 13%. reducing the cost of a quart of milk from 2.83 cents to 2.17 cents, thus nearly reaching the level of the first period.

Period eighth shows a marked falling off in yield of milk in all cases. The total for herd falls off 12%, the total for the ten cows whose individual record was kept drops 11%. The only change of food in this period was the substitution of two pounds mixed corn and oats in place of the gluten and corn mixture of Period 7, but as only 1¼ pounds of the latter had been fed the two pounds would be fully equivalent, hence we must look for some other cause for this sudden decrease. In Cut 1, Sec. 3, I have plotted a curve representing the average temperature for each period. This curve is made up from Table C.

TABLE C.

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Av. temp. in degrees,	35	30	27	15	19	11½	0	-1	18½	12	17	31	12	18½	31½	24	28

These are out door and not stable temperatures.

It was noticed that the temperature was not sufficiently variable to make any appreciable difference in-doors during the first six periods, but during the 7th period there were two days of very cold weather followed by a few days of warm weather. These two days brought down the average temperature but did not affect the milk flow as the stable temperature was not greatly reduced, but in the eighth, a severe period of windy days, unusually low temperature, made the stables very cold. This condition of affairs undoubtedly caused the falling off in product, and therefore the food cannot be charged with being of less nutritive value. During Periods 9 and 10 there was an increase of milk, but only slight. From 10 to 15 there is a comparatively uniform falling off amounting to 2% per period.

Digitized by Google

The result of this was to slightly but constantly increase the cost per quart of milk.

Period 16 marks a radical change of food and a sudden falling off of milk flow, amounting to nearly 22%. The food for this period was early cut herdsgrass hay, clover mixture, and the same grain mixture as previously fed. So radical a change from succulent food to dry fodder might naturally be expected to cause a shrinkage out of proportion to the actual fall of feeding value of fodder, but it will be noticed that although the cows were fed all they would eat yet there was but 10½ pounds eaten daily, which, at the prices adopted for estimating values makes the cheapest daily ration fed so far as actual cost is concerned. The shrinkage was so great that financial considerations induced us to change the ration at the end of a single period back to the former ensilage ration, and by so doing the yield was brought back by half the amount of the previous shrinkage.

At this point the ensilage gave out and in its place a ration containing cured corn fodder was substituted, also a large addition was made to the grain portion of the food. A substantial increase of milk was the result.

TABLE D.

LIVE WEIGHT OF TEN COWS FOR TWENTY-ONE PERIODS.

Period,	1	2	3	4	5	6	7	8	9	10	11
Weight,	9049	9119	9083	9003	9145	9157	9127	9006	9101	9097	9221

Period,	12	13	14	15	16	17	18	19	20
Weight,	9107	9154	9069	9119	8905	9280	9358	9254	9399

This shows a moderate increase in live weight throughout, though in Period 8 the effect of the cold weather is indicated by a shrinkage.

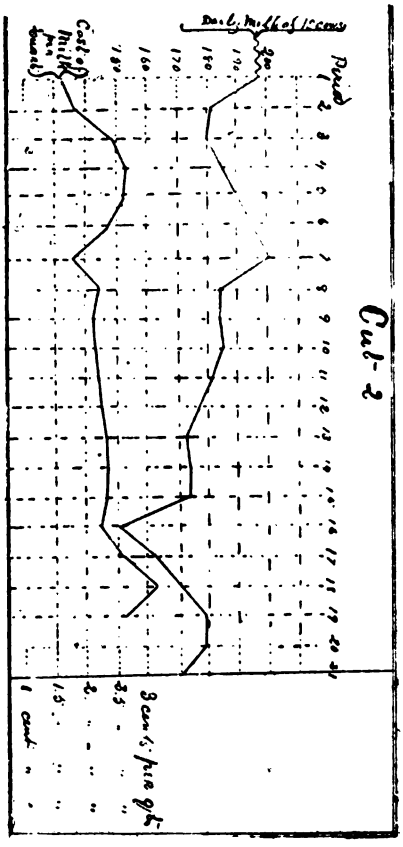
Cut 2 shows by a curved line the daily yield per period of the ten cows whose individual record was kept, and also by another curve, the price per quart of milk. This last is important, showing as it does the financial side of the whole work.

COST OF PRODUCING MILK.

Commencing at Period one we find the cost to be 1.65 cents per quart. Changing onto Southern ensilage increases this to 1.86 cents, and in our efforts to restore the loss of yield

Digitized by Google

by feeding more meal we made milk at a cost of 2.47,2.70, 2.68 and 2.36 cents. The upward tendency of the curves in periods



2–5 show increased cost. Period 6 shows that a substitution of gluten meal instead of the grain previously fed had the effect of materially reducing the cost. Period 7 marks a low cost and a high yield. With the loss of yield in Period 8 we note an increased cost, and then follows several periods of dimishing yield and slowly increasing cost. Period 16 shows an unusual circumstance; the sudden falling off of milk would under most circumstances be attended by an increased cost per quart, but in this case both quantity and cost go down at the

Digitized by Google

same time. This is followed by a sharp increase both in quantity and cost.

Taking all the results as they stand our ten cows produce milk at the following average prices:

TABLE E.

Food.	Whole Herd. cts. per qt.	Ten Cows. cts. per qt.	*Best Cow. cts. per qt.	Poorest Cow. cts. per qt.
Sanford,	2.02	1.65	1.32	2.69
Southern Corn,	2.92	2.44	1.95	4.49
Northern Corn,	2.54	2.24	1.66	4.04
Hay,	2.79	2.28	1.20	4.73
Corn Fodder,	3.45	2.92	1.81	5.35

*After the 13th period a new cow, No. 4, came in and this reduced the individual cost of milk produced for "best cow."

G. H. WHITCHER,

Director.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

The Farm H
University of Nebra

AGRICULTURAL

EXPERIMENT STATION,

HANOVER, N. H.,

BULLETIN NO. 3.

WHEN TO CUT CORN FOR ENSILAGE.

JULY, 1888.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

Digitized by Google

WHEN TO CUT CORN FOR ENSILAGE.

Several inquiries have been addressed to this station relating to the time of cutting corn for ensilage, and as the season for securing this crop is rapidly approaching I have changed my original plan of issuing a bulletin on Chemical Fertilization and have substituted in its stead a partial answer to the above mentioned questions.

There must be a time somewhere between seeding and full maturity when corn is at its best as a forage crop, and it has been our aim to practically determine this, if possible.

The data presented in this bulletin is not offered as conclusive evidence in the case but simply as the first step towards proof, and but for the demand for information on the part of the farmers I should prefer to have another year's results before publishing those of last year. The plan of the work was to select samples from each of the four varieties of corn experimented with at various intervals and to note their height, weight and degree of maturity. The per cent. of water was then determined and a complete analysis of the dry substance made. This work was carried out as fully as the limited means at that time available would permit. The amount of work was too small for the best results but so far as it went it was carefully conducted.

Table A shows as follows: Column 1 the variety of corn, 2 date of sampling, 3 per cent. of water at the time samples were taken, 4. per cent. of dry substance; the next seven columns show the per cent. of albuminoids, ether extract, fibre, nitrogen free extract, total ash, phosphoric acid and potash. In other words this table shows complete analysis of four varieties of corn at four periods, or in all sixteen analyses.

In any article of food whether for man or beast the valuable part, or that which sustains life and nourishes the body, is included in the dry substance, hence it is not always the total weight that is the best guide, but it is often true that the weight

Digitized by Google

is a very poor indicator of value. The method of determining the dry matter in any substance is a comparatively simple one in the laboratory; a small sample is weighed and dried at a

TABLE A.

Kind of Corn.	Time of sampling.	Chemical composition. Water.	Dry substance.	Albumenoids.	Ether extract.	Fibre.	Nitrogen free extract.	Ash.	Phosphoric acid.	Potash.	100 parts of water free or dry substance contain: Albumenoids.	Ether extract.	Fibre.	Nitrogen free extract.	Ash.
Southern Ensilage Corn.	July 26.	91.25	8.75	1.6	.34	2.03	3.99	.79	.0121	.0340	18.31	3.9	23.2	45.59	9.0
	Aug. 5.	89.19	10.82	1.52	.51	3.05	4.81	.93	.0295	.0613	14.06	4.7	28.2	44.44	8.6
	Aug. 19.	84.95	15.05	2.25	.75	3.90	7.11	1.04	.0275	.0572	14.98	5.0	25.9	47.22	6.9
	Sept. 16.	75.40	24.6	2.30	.58	5.95	14.58	1.13	.0269	.0917	9.59	2.35	24.2	59.26	4.6
Sanford.	July 26.	90.85	9.15	1.42	.61	2.06	4.31	.75	.0271	.0604	15.61	6.7	22.5	40.99	8.2
	Aug. 5.	86.79	13.21	1.63	.73	3.06	6.88	.90	.0368	.0457	12.35	5.5	23.15	51.70	7.3
	Aug. 19.	86.75	13.20	1.49	.57	3.28	7.27	.73	.0673	.0322	11.26	4.3	24.1	54.84	5.5
	Sept. 16.	77.2	22.80	2.11	1.01	4.81	13.85	.93			9.25	4.73	21.07	60.75	4.1
Pride of North.	July 26.	90.65	9.35	1.63	.44	2.29	4.00	.99	.0619	.0894	17.50	4.7	24.45	42.75	10.6
	Aug. 5.	87.56	12.44	1.97	.56	3.35	5.55	1.02	.0558	.0886	15.81	4.52	26.9	44.61	8.16
	Aug. 19.	82.25	17.75	1.92	.67	3.97	10.27	.90	.0688	.0414	10.83	3.9	22.34	57.86	5.07
	Sept. 16.	70.45	29.55	3.29	1.59	6.04	16.9	1.77	.0388	.0342	11.00	5.35	20.45	57.20	6.00
Northern Field Corn.	July 26.	87.75	12.25	1.79	.82	2.99	5.58	1.07	.0367	.0341	14.58	6.7	24.4	45.57	8.75
	Aug. 5.	86.10	13.90	1.88	.62	3.25	7.51	.66	.0392	.0268	13.44	4.4	23.4	54.08	4.68
	Aug. 19.	81.45	18.55	1.89	.59	4.56	10.48	1.02	.0398	.0534	10.2	3.2	24.6	56.52	5.48
	Sept. 16.	72.40	27.60	2.65	1.30	4.72	17.17	1.69			9.6	4.7	17.35	62.23	6.13

temperature of 212 degrees until it no longer loses weight, then the final weight is noted, and the difference between this and

Digitized by Google

the original weight of sample shows the amount of water that was originally in the substance under consideration, for at the temperature above mentioned only the water is driven off.

Taking our third column in the table and it is seen that at any time there is a very large per cent. of water in the corn. Take for illustration the sample of ensilage (Southern) corn July 26. Here was 91¼% of water. From Table F we see that an average stalk weighed 15 ounces; 91¼ per cent. of fifteen is 13.68, the amount of water which such a stalk contained, leaving only 1⅓ ounces of dry substance. Take the same variety of corn Sept. 16 and there was still 75.4% of water, and as an average stalk weighed almost three pounds, it follows that each stalk contained 2 lbs, 3½ ounces, or more than a quart of pure water, leaving but three-fourths of a pound of actual nutritive matter. This point is dwelt upon for the purpose of showing that pounds or tons per acre are not necessarily a reliable standard of value, and also to show that not everything stored in the barn or in the silo is food, but rather that in these cases but a small portion is actual nutrient material. A study of Table A shows that in each variety of corn there was a substantial increase in the per cent. of dry matter, as is shown by Table B, in which the number of pounds of dry substance in a ton of the corn is given for each variety at each time of sampling.

TABLE B.

POUNDS OF DRY SUBSTANCE IN ONE TON OF 2000 LBS.

Date.	Southern or ensilage corn.	Sanford.	Pride of the North.	Northern field corn.
	lbs.	lbs.	lbs.	lbs.
July 26,	175	183	187	245
August 5,	216	264	248	278
August 19,	301	264	355	371
September 16,	492	456	591	552

It will be seen from this that the value of the corn per *ton* increased in a marked degree from August 19th to Sept. 16th, but this is deceptive as a part of this is due to a decrease of weight per acre by loss of water in maturing. So far as it extended this loss was precisely like the drying of hay, making the increased value *per ton* very marked, but from Table F it will be seen that the actual increase per *acre* is much less.

Digitized by Google

In Table C I have arranged the per cent. of increase per *ton* and per *acre* for the period from Aug. 19th to Sept. 16th.

TABLE C.

VARIETY.	PER CENT. OF INCREASE OF DRY SUBSTANCE FROM AUG. 19 TO SEPT. 16.	
	Per Ton.	*Per Acre.*
Southern Corn,	63.4 per cent.	37.7 per cent.
Sanford,	72.7 "	32. "
Pride of the North,	66.4 "	16.8 "
Northern Field,	48.8 "	35.3 "

and a glance at this is sufficient to show that a part of this apparently large gain per ton is not a gain at all. The fact remains however that there is about 33% of actual gain in this last period.

Returning to Table B we shall see that there is a marked difference not only between the varieties but also in the same variety at different dates, and so far as this table is concerned it is evident that the *quality* of the product in every case improved up to the time of cutting.

TABLE D.

Variety of Corn.	Estimated dry substacce, *per acre.*				Per cent of increase for each period over the preceding one.			Gain per cent from July 26 to Sept. 16.
	July 26.	Aug. 5.	Aug. 19.	Sept. 16.	Aug. 5.	Aug. 19.	Sept. 16.	
Southern,	1147	3536	7333	10102	207.4	107.3	37.7	780.7
Sanford,	972	3919	5292	6980	303.2	35.3	32.0	618.0
Pride of North,	1012	3366	6340	7410	232.6	88.3	16.8	632.2
Northern Field,	2135	4925	6519	8832	126.	32.4	35.3	313.6

Table D is made up from Table F and shows in a condensed form the rate of increase of dry matter. In discussing this table it must be borne in mind that the four varieties of corn

TABLE E.

Condition of corn as regards maturity.

Variety of Corn.	July 26.	Aug. 5.	Aug. 19.	Sept. 16.
Southern,	Tassel not formed.	Tassel not in sight.	Silk just in sight.	Kernel blistering
Sanford,	Tassel just in sight.	Tassel out but no silk.	Kernel blistering	Kernel full.
Pride of North,	Tassel not in sight.	Tassel and silk in sight.	Kernel well formed, silk brown.	Kernel full.
Northern Field,	Tassel well out.	Kernel blistering	Kernel full but not glazed.	Kernel wholly glazed, husk yellow.

Digitized by Google

were unequally developed though planted at the same time. Some were earlier than others, and from notes recorded when the samples were taken I have prepared the following table showing in a concise form the relative condition at each period.

The Sanford and Pride of the North, the latter being a dent corn raised in Minnesota, were about alike in earliness, the Sanford being a little ahead July 26 and a little behind Sept. 16, showing that the Minnesota corn is a little more rapid in growth, thus making it a little more certain in maturing its seed. It will be seen from Table D that the Sanford increased much more from July 26 to Aug. 5 than did the Pride of the North, but for the next period the increase was reversed. For the whole period, however, the increase was nearly the same. With the Southern corn the increase of dry substance was very marked up to Aug. 19, at which time its tassels were not in sight. This rapid gain no doubt continued for several days after this date. The total gain from July 26 to Sept. 16 is greater in this variety than in either of the others. Because its period of rapid increase is longer and if early frosts did not interfere with the perfect maturity of this variety there is no doubt but that it would produce a more profitable crop per acre than any kind of corn thus far experimented with, but as a matter of fact this variety, in point of development, is in the same condition Sept. 16 that the Sanford is a month earlier or the Northern field corn forty days earlier.

The Northern field corn increased less than either of the other varieties, but this is more apparent than real for it was so far developed July 26 that it had a large amount of dry substance, in fact its period of rapid increase was past, it being fully twelve days ahead of the Sanford and Pride of the North, and forty days ahead of the Southern.

TABLE F.

Variety of Corn.	Plants per acre.	Weight per stalk.				Computed weight per acre.			
		July 26.	Aug. 5.	Aug. 19.	Sept. 16.	July 26.	Aug. 5.	Aug. 19.	Sept. 16.
		oz.	oz.	oz.	oz.	lbs.	lbs.	lbs.	lbs.
Southern,	13980	15	37.4	56	47	13106	32678	48875	41066
Sanford,	17750	9.6	26.8	36	27.6	10625	29688	39937	30618
Pride of North,	14433	12	30	39.6	27.8	10824	27061	35721	25077
Northern Field, (flint),	22857	12.2	24.8	24.6	22.4	17428	35428	35142	32000

Digitized by Google

Table F. continued.

Variety of Corn.	Actual amount of water, dry substance, and the separate constituents of the dry substance per acre, for each variety of corn at each of the four dates at which samples were taken, (these are in pounds per acre).																	
	July 26, 1887.									August 5, 1887.								
	Water.	Dry substance.	Albumenoids.	Ether Extract.	Fibre.	Nitrogen free extract.	Ash.	Phosphoric acid.	Potash.	Water.	Dry substance.	Albumenoids.	Ether Extract.	Fibre.	Nitrogen free extract.	Ash.	Phosphoric acid.	Potash.
Southern,	11959	1147	209.7	44.5	262	523	103.5	1.6	5.5	29142	3536	496.7	166.6	996.6	1572	304	9.8	20
Sanford,	9653	972	151	65	218	458	80	2.8	6.4	25769	3919	484	216	908	2042	267	17	12
Pride of North,	9812	1012	176	48	247	433	107	6.7	9.6	23695	3366	533	151	906	1501	276	15	24
Northern Field, (flint),	15293	2135	312	143	521	972	186	6.4	6.0	30503	4925	665	219	1150	2660	232	13.8	10.3

Variety of Corn.	August 19, 1887.									September 16. 1887.								
Southern,	41542	7333	1093	366	1905	3474	490	13.4	28	30764	10102	969	238	2443	5987	464	11	37.6
Sanford,	34645	5292	595	227	1309	2973	291	27	13	23637	6980	646	331	1473	4241	285		
Pride of North,	29381	6340	686	240	1419	3669	322	24.6	14.3	17667	7410	815	399	1514	4238	444	22.3	8.6
Northern Field, (flint)	28623	6519	664	208	1603	3684	359	14	19	23168	8832	848	416	1533	5404	541		

Digitized by Google

In all the varieties there was a great falling off in the rate of increase immediately after the tassels are put forth, the plant evidently accumulating dry substance much more rapidly while the tassels were being developed than at any subsequent period.

Table F shows the computed amount of total crop and of each constituent of the crop per acre for each variety and each period. The general indications of this table have already been noted. In the final results at harvest time it appears that the Southern corn produced the most dry substance per acre, also that the Northern field corn came next, Pride of the North next and Sanford last, but as was shown in Bulletin 2 the feeding results show best for Sanford, the Northern coming next and the Southern last. The Pride of the North was not experimented with in feeding.

Just why the economy of the three varieties should be the reverse of their product per acre is a question hard to answer. In the case of the Northern field corn it was fed to cows that had been long in milk, and therefore the natural shrinkage would make the cost per quart of milk greater even on the same food, and it is fair to presume that under like conditions there would have been no great difference in feeding value, but why the Sanford should prove so much the superior of the Southern can only be attributed to the fact of its being a mature plant while the rank and late Southern corn was immature, and although chemical analysis shows them to have been nearly alike, yet the condition of the nitrogenous matter may have been such that pound for pound it was less valuable. This point could only have been determined by separating the albumenoid from the non-albuminoid nitrogen.

In conclusion we may say that, all things considered, it is best to plant such varieties as will in a given locality produce plants having well filled ears, the kernels being in the milk or better still in the "doughy" state, and to delay the harvesting until the plant shows evident signs of ripening such as the turning of the lower leaves, the glazing of the kernel in the flint or the shrivelling of the dent varieties. Up to this point there is a gain in two ways: first, an actual gain in the dry matter as shown by Table F, and second, a loss of water, (see Table A) reducing the ratio between the water and dry sub-

Digitized by Google

stance to about that required by cattle, thus improving the ensilage and reducing the labor in handling.

G. H. WHITCHER,

Director.

Address all communications to the New Hampshire Agricultural Experiment Station, Hanover, N. H.

These Bulletins are free to farmers in New Hampshire and a postal card with full address is all that is required to insure to any one all the Bulletins and Reports as issued. There is an opinion among many that Bulletins will be issued *monthly*. This is wrong. Bulletins will be issued as fast as there is material which is of interest, but under no condition will this station issue bulletins unless such material has accumulated whether the period is one month or three, for there can be no greater mistake than to suppose that bulletins can be issued regularly. The law establishing this station wisely recognized this fact aud only required that four be issued annually.

G. H. WHITCHER.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION,

HANOVER, N. ,

BULLETIN NO. 4.

THE SCIENCE AND PRACTICE OF STOCK FEEDING.

NOVEMBER, 1888.

Digitized by Google

HARVARD COLLEGE
FEB 21 1929
LIBRARY

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

BOARD OF CONTROL:

Hon. Warren Brown, Chairman,	Hampton Falls.
Hon. S. B. Whittemore,	Colebrook.
Hon. G. A. Wason,	Nashua.
Prof. G. H. Whitcher,	Hanover.
Prof. T. W. Kinkaid, Secretary,	Hanover.

OFFICERS:

G. H. Whitcher,	Director.
A. H. Wood,	Supt. Dairy Dept.
H. H. Lamson,	Microscopist.
F. W. Morse, E. H. Farrington, C. L. Parsons,	Asst. Chemists.
C. H. Pettee,	Meterologist.
T. W. Kinkaid,	Consulting Engineer.
J. M. Fuller,	Station Farmer.
H. L. Barnard,	Clerk.

Digitized by Google

THE SCIENCE AND PRACTICE OF STOCK FEEDING.

For the next two hundred days the subject of stock feeding must necessarily occupy much of the time and attention of the successful New Hampshire farmer, and as the importance of this subject is often overlooked I will will briefly state the latest available statistics on live stock.*

There are within our State, to-day, not far from 60,000 horses, 20,000 oxen, 95,000 cows, 50,000 other cattle, and 150,000 sheep, and the success of the year's agricultural work depends largely upon the profitable feeding of these, for it is just as important to dispose of the fodder economically as to produce it cheaply.

We will assume that the average horse weighs 1,000 pounds, the ox 1,400, the cow 900, other cattle 400, and the sheep 100. This gives us the following aggregate, live weight:

60,000 horses,	@	1,000 lbs.,	60,000,000
20,000 oxen,	@	1,400 lbs.,	28,000,000
95,000 cows,	@	900 lbs.,	85,500,000
50,000 other cattle,	@	400 lbs.,	20,000,000
150,000 sheep,	@	100 lbs.,	15,000,000
Total weight of all neat stock, horses and sheep,			208,500,000

It has been found, by numerous experiments, that on an av erage, it will require twenty pounds of hay, five pounds of corn meal, and two pounds of cotton seed, or an equivalent of these, daily for one thousand pounds of live weight,—this is necessarily an average for horses, oxen, sheep, cows, and growing cattle,—with this standard we find that the daily amount of hay and grain required for the entire winter are as given below:

	Daily.	For winter of 200 days.
Hay required,	2,085 tons,	417,000 tons.
Corn meal, "	521¼ tons,	104,250 tons.
Cotton seed, "	208½ tons,	41,700 tons.

*Report of State Board of Equalization, 1887.

Digitized by Google

Referring to the Census of 1879, (and it is probable that our agricultural products have not varied greatly since then,) we find that we produced 588,170 tons of hay, and about 80,000 tons of corn fodder, oat, wheat and barley straw, and if we call these two-thirds as valuable as hay it will bring our available hay up to 641,500 tons.

We also produced 32,806 tons of corn, and 16,281 tons of oats, and as they are of practically the same feeding value, the whole may be stated as equivalent to 4,000 tons of corn meal. It appears, then, that we have a surplus of some 225,000 tons of hay, and a deficit of 55,225 tons of corn meal, and 41,700 tons of cotton seed, or the equivalent of these in some other grain.

To get some idea of the money value represented by these figures I have called the cost of hay, corn meal and cotton seed $8.00, $20.00 and $25.00 per ton, respectively. On this basis the following tabular statement is computed:

417,000 tons of hay,	@ $8.00,	equals $3,336,00
104,250 tons of meal,	@ 20.00,	equals 2,085,00
41,700 tons of cotton seed,	@ 25.00,	equals 1,042,500
Total value of food required for 200 days,		$6,463,500

While the total of the hay, straw, corn fodder, corn and oats produced amounts to $6,119,100; thus showing that we are producing very nearly the amount of food that is required by our live stock, exclusive of poultry and hogs. But to make this fodder produce the best results it is necessary to exchange the 225,000 tons of hay for grain. Here is where a study of the science of stock feeding may aid us in the practical work. I have very little doubt but that better results might be obtained, at less cost for food, if the rations fed were better proportioned. A saving of even five per cent would amount to $323,175 in the aggregate, and I believe much more than this may be saved.

At the outset I wish to say, that the science of stock feeding is the key to better practical work. It should go hand in hand with the practice, pointing out possible improvements, and showing the losses which many old methods entail. Science can never take the place of practical knowledge, but it can point out the methods which lead to success. True science and *good* practice never conflict; if theory and practice lead to opposite conclu-

Digitized by Google

sions, either the science or the practice is wrong. A practice not based upon science may be right, or it may be wrong, just as a man may guess right or wrong, but at best such practice, whether in agriculture or engineering, contains too many elements of uncertainty. Few would care to contend that the Brooklyn bridge could have been built without first, theoretically, determining the strain on each part; before a blow was struck the strain on every piece in that great structure was computed, and also the dimension of the parts required to safely withstand this load.

Good judgment, unaided by the science of the civil engineer, could hardly have directed the efforts of two gangs of men from points five miles apart, and given us the Hoosac tunnel. The fact that small enterprises are carried through successfully without the aid of science is too often used as a argument that theory is useless; because some small stream has been successfully bridged by some one who never knew how to compute the strain on a given brace, or post, or rod, therefore there is no need of applying the principles of mechanics to bridge building. This kind of reasoning is all wrong, and, to-day, no engineering project is undertaken without first working out the most minute details from a theoretical standpoint. Every brace and bolt, post and pin, every block of granite, first appears "on paper" in the office of the draughtsman, before a blow is struck by the workmen, who are to construct the bridge.

Theory and practice must go hand in hand to arrive at the best results in the best way. This is as true in agriculture as in any other pursuit.

The two factors with which we have to deal in stock feeding are *plants* and *animals*, and we will briefly consider the principles of their growth and composition.

Plants and *animals* are *mutually dependent* for their existence. Without *plants*, *animals* would perish, and without *animals*, *plants* would in time die for lack of an atmosphere suited to their wants.

PLANT GROWTH.

When a kernel of corn is planted under favorable circumstances it produces a stalk and ear that may weigh five pounds. It is evident that the little kernel, weighing but a small fraction of an ounce, could not have furnished all the material from which

Digitized by Google

the stalk was produced, and the soil and atmosphere must have made up the deficiency.

The leaves of the growing plant absorb from the atmosphere a gas, known as carbonic acid gas; the roots take up water, in which potash, iron, sulphur, lime, phosphoric acid, and magnesia, are dissolved, and the roots and leaves both take up nitrogen in combination with other elements. Within the plant these simple substances are combined in wonderful ways, forming many compounds having unlike properties, for example, the carbonic acid taken in through the leaves, and the water taken up by the roots, furnish the elements from which starch, sugar, oil, vegetable acids, mucilage, gum, etc., are produced. By the addition of nitrogen and sulphur a class of compounds are produced which resemble the white of eggs. Wheat gluten is an example of this class. One of the chief characteristics of plants is this power of taking the elements contained in the soil and air, and from a few, forming an almost endless variety of substances having the most diverse properties. Sugar and acids, starch and oil, strychnine and quinine, are a few of the many. This power is not found in animals. Not a grain of starch was ever produced from the elements of carbonic acid and water, except by plants; animals are dependent upon plants for their food. During the growth of plants they are constantly taking in carbonic acid, using a part of it in the production of starch, sugar, etc., and giving off oxygen; the result of this is to use up the carbonic acid of the atmosphere and overcharge it with oxygen; animals, however, produce just the opposite effect; they take in and use oxygen and give off carbonic acid. This is the one thing that keeps nature's books balanced.

A plant put under a tight jar would in time so far use up the carbonic acid as to die from lack of food; a mouse under another jar would use up the oxygen and increase the carbonic acid until suffocated; the two if put under the same jar would keep the air right for both. The oxygen given off by the plant would supply the mouse while the carbonic acid exhaled by the mouse would furnish just the kind of food necessary for the plant.

FOOD.

This word has been used. What does it mean? Any substance that can support life, or help to support it, is *food*.

Digitized by Google

Plants require *food* to support them when growing, they find it in the air and in the soil. The food of animals consist of any and all substances which can be taken into the system and which contribute toward supporting life, or causing growth, and is prepared for them by plants. A *food* may be *complete* that is capable of furnishing all that an animal requires, as grass, or it may be *incomplete* or not capable of sustaining life, when fed alone, e. g.. starch, sugar, oil, etc. These are just as much food, however, as grass.

It has been intimated already that plants are made up of unlike parts, or constituents, and the first step towards and understanding of the use of food is to know what the food is, the chemist must be consulted in determining this. It is true that the eye detects differences in the external appearance of food, but if some one should ask for the exact difference between corn meal and shorts it would be impossible to answer him, without knowing the chemical composition of the two. In the machine shop the mechanic learns the peculiarities of different machines by taking them apart and noting their construction. In the laboratory the chemist learns the characteristics of various plants and fodders by taking them apart, so to speak, instead of the vise he uses the crucible, in place of the monkey wrench he uses various acids, alkalies, etc., to tear apart the plant and separate it into the constituents of which it is made up; instead of the accurate rule measuring to the $\frac{1}{10000}$ part of an inch he uses delicate balances, which weigh to the $\frac{1}{28350}$ part of an ounce. The object of both the mechanic and the chemist is to get a knowledge of the internal structure which simple inspection cannot give. If plants were made up of but one kind of material there would be no need of chemical analysis. But such is not the case. If we press out the juice of a stalk of corn and evaporate it we get *sugar;* if the dried kernels are ground into a paste, with water, and then washed and manipulated in certain ways a large per cent of *starch* is obtained. If another sample of this corn meal is boiled with ether and the ether poured off into a clean dish and evaporated there will be found a clear yellowish oil, *or fat,* which the ether dissolved out of the corn. If wheat dough is washed until the starch is removed, a tough, sticky mass is left, this is known as *gluten.* These four substances represent the most important constituents found in fodders.

Digitized by Google

The chemical composition of fodders and feeding stuffs is determined and expressed in the following way: *Water* exists in all plants, the amount is determined by weighing a sample of the given substance and then drying it at 212°, until it ceases to lose weight, the loss is water, the part which remains is called *water free substance* and is made up of; 1st, *albuminoids* or substance resembling albumen or the white of eggs, wheat gluten or "wheat gum," already alluded to is the most familiar illustration of this class. The albuminoids contain not far from sixteen per cent of nitrogen and on account of this they are spoken of as the nitrogenous constituents. 2nd, *Nitrogen Free Extract* includes starch, sugar, substances resembling gum, mucilage, etc. 3d, *Fiber;* this is the woody matter found in all plants, in the flax and in cotton plant it is the part that gives us the material from which linen and cotton cloths are made. 4th, *Fat;* this is determined by dissolving with ether and evaporating the ether, leaving the fat or oil to be weighed. In the seeds of some plants, for example, cotton and hemp, the fat is found in large quantities and is pressed out and used for numerous purposes. 5th, *Ash;* This is the part left after burning a sample of the substance.

The following table shows the chemical composition of corn meal and shorts; the figures are an average of many determinations made at the Massachusetts Experiment Station:

	Corn meal.	Shorts.
Water,	13.16	11.5
Water free substance,	86.84	88.5
Water free substance contains:		
Albumenoids,	10.19	16.1
Nitrogen free extract,	68.92	52.3
Fiber,	2.50	10.0
Fat,	3.87	4.0
Ash,	1.36	6.1
	86.84	88.5

This is the customary method of stating an analysis, showing the *total composition* of fodders. But it is not in shape to be used by the feeder as a means of determining the nutritive value of these two products, because the animal fails to get the full amount of nutritive matter shown by analysis. Food, to be of

Digitized by Google

any value to an animal, must be rendered soluble, so that it can be absorbed and carried through the system in the blood. This process of making the constituents of the food soluble is known as *digestion*, and is effected by the juices of the mouth, stomach, intestines, etc. If animals could digest the whole of the albumenoids, or other parts of corn meal or shorts, then the analyses above given would show the nutritive value. But it has been found that such is not the case. Only a part of each substance is digested. We may illustrate this point by supposing that some one puts on the market a mixture of coal and gravel stones, eighty pounds of the former and twenty pounds of the latter, in each one hundred pounds. The value of this, as fuel, is only that of the eighty pounds of coal, and any estimate based upon the *total weight* would be erroneous. In the same way each constituent of corn meal is made up of two parts, one *digestible*, corresponding to the coal in our assumed mixture; the other, *indigestible*, and corresponding to the gravel stones. The value of any kind of food is based, not on its total total composition, but on the *digestible* parts. It is necessary, therefore, to know what portion of each constituent is rendered available by the digestive juices. The method employed is briefly as follows: An animal is placed in a stall where no food can be wasted, a record of all food consumed is kept, and from the analysis it is possible to compute the exact amount of *albuminoids, fibre, nitrogen free extract* and *fat*, that has been taken into the system during the entire experiment. All the parts of the food that are not digested pass unchanged through the intestines and are found in the manure, consequently, if all the manure is weighed and samples are analysed, it is easy to compute the albumenoids, fibre, nitrogen, free extract and fat, that has passed through the animal unchanged, and these subtracted from the amounts taken into the system will show what portion has been rendered available by digestion. The degree of digestibility is usually expressed by stating the number of pounds that are digestable in one hundred pounds of each constituents. For example, it has been found that of each one hundred pounds of albumenoids fed in corn meal eighty-five pounds are digested. This eighty-five represents the *per cent* of digestibility of albuminoids in corn meal, and is called *digestion co-efficient*. Of the nitrogen free extract, ninety-four out of every one hundred pounds is digestible, in

Digitized by Google

other words, ninety-four is the *digestion co-efficient* of the nitrogen free extract of corn meal. In the same way it is found that thirty-four and seventy-six are the digestion co-efficient of the fiber and fat, respectively. For shorts the figures are eighty-eight, eighty, eighty, and twenty, for albumenoids, nitrogen free extract, fat and fibre. To get the analyses above given into shape to be of value to the feeder, it is necessary to determine what the composition is when *only* the *digestible* part is considered. This is done in the following table:

	Corn Meal.			Shorts.		
	Total composition.	Digestion co-efficient	Amount digestible in 100 lbs. meal.	Total composition.	Digestion co-efficient	Amount digestible in 100 lbs. shorts.
Water,	13.16			11.5		
Water free substance,	86.84			88.5		
Albuminoids,	10.19	85	8.66	16.1	88	14.17
Nitrogen free extract,	68.92	94	64.78	52.3	80	41.84
Fiber,	2.50	34	.85	10.0	20	2.00
Fat,	3.87	76	2.94	4.0	80	3.20
Ash,	1.36			6.1		

In this table, in the third and sixth columns we have the available nutritive material in corn meal and shorts, but as the digestible nitrogen free extract and digestible fiber are equally valuable these two may be added together, and in most stock feeding tables this is done, the name carbo-hydrates being given to the sum of the two, this term, carbo-hydrate, means that portion of the digestable part of food which is made up of three elements, carbon, hydrogen and oxygen, the last two elements being in the ratio of two parts of hydrogen and one part of oxygen. The ordinary table would give the above results in the following form:

	Digestible.		
	Albuminoids.	carbo-hydrates.	Fat.
Corn meal,	8.66	65.63	2.94
Shorts,	14.17	43.84	3.20

In the tables given in this bulletin I propose to modify this form of statement, with the hope that it will very much simplify the matter of using them in practical work, and I will explain the modification at this point. It is customary to give what is called the *nutritive ratio* of each food. Warrington calls it the *albuminoid ratio.* This means the ratio of digestible albuminoids or nitrogenous matter, to the carbo-hydrates and *fat*, or non-nitrogenous matter, but as it has been found that a pound of *fat* will produce 2½ times as much *heat*, when burned, as a

Digitized by Google

pound of *starch* or *sugar* it has been assumed that the *fat* in fodders is 2½ times as valuable as the *carbo-hydrates* for feeding purposes, consequently in determining the *nutritive ratio* the *fat* is multiplied by 2½ and the product added to the carbo-hydrates this has the effect of making the whole of the non-nitrogenous part of the food appear as starch or sugar. An example will best show how this is done. Take the corn meal above tabulated, there are 8.66 pounds of digestable albuminoids; There are of carbo-hydrates (starch, sugar, fibre etc.,) 65.63 lbs., of fat 2.94 lbs., multiplied by 2½ gives the equivalent of carbo-hydrate 7.35; the carbo-hydrate equivalent becomes 72.98; the ratio of nitrogenous to non-nitrogenous is as follows: 8.66 to 72.98, or as 1 : 8.4. This last is the nutritive ratio of corn meal. The modification alluded to is this: instead of giving the carbo-hydrates and fat in *separate* columns I shall multiply the *fat* in each food by 2½ and *add* it to the carbo-hydrates, and give the sum in one column under the term *carbo-hydrate equivalence.* The reason for this will appear in the practical work of computing rations, under "practical feeding."

The table last given would be changed to the following:

	Albuminoids.	Carbo-hydrate equivalence.	Nutritive ratio.
Corn meal,	8.66	72.98	1 : 8.4
Shorts,	14.17	51.84	1 : 3.6

What are the *uses of food* in the animal system?

Having considered what *food* is and finding it made up of parts having unlike qualities it is very natural to ask if the albuminoids and corbo-hydrates are of equal value, before this can be answered it will be best to see why animals require food. Some of the uses of food may be best explained by comparing the animal to the locomotive. We will take the case of a locomotive, standing idle in the yard, with the temperature of the atmosphere at zero. Under these conditions heat is constantly being given off to the air, and, if left to itself, after a time the fire goes out, the water gradually cools off, until it freezes. This tendency is caused by what is known as *radiation* of *heat* and the result is that the locomotive and air in time come to the *same temperature.* To prevent this, either wood or coal is burned in the fire-box. An ox, standing in a cold barn, or out of doors, loses heat by radiation, just as the locomotive does and is this loss was not made good in some way, it would only be a

Digitized by Google

short time before the temperature of the air and the temperature of the ox would be alike. But as a matter of fact the temperature of the blood never varies much from 101° in health, and it makes no difference whether the air is at 30° below zero or at 90° above. The temperature of the body is kept up by the *food* consumed just as that of the locomotive is by the wood burned. Again the fuel consumed by a locomotive while standing idle is only, an amount suffcient to supply the loss of heat. This is a comparitively small amount, when the same locomotive is coupled to a train of loaded cars, and is started on an up grade, it will be found necessary to open the drafts and increase the consumption of fuel, in drawing this load, energy is required and this is obtained from the extra fuel consumed. An ox or a horse, when drawing heavy loads, must also expend more energy than when standing in the stall, and to develope this energy requires more food : *food* is to the ox what *fuel* is to the locomotive.

There is one other object for which we feed, namely, the production of growth, under this head comes increase of live weight whether in growing animals or fattening one, growth of wool, or the production of milk. If an animal weighs one hundred pounds at birth and fifteen hundred pounds when three years old this gain of fourteen hundred pounds mus' come from the food and water used, if a cow yields annually, six thousand pounds of milk, this also must come from the food and water consumed.

The uses of food, then, are : to produce heat ; to produce force, (muscular energy) ; to produce new tissue, (including increase of live weight, growth of wool or yield of milk).

Having noted the use to which food is put we may inquire whether one part of the food is better adapted to one requirement, and another part to another requirement, or whether all the digestible parts are equally effective.

1st, what part of the food produces heat. The best authorities answer this by saying that the changes which take place in all parts of the body produce heat. The contraction of a muscle, the activity of the liver, etc., all liberate heat and hence it cannot be said that one constituent of the food more than another is the source, but that both the nitrogenous and non-nitrogenous contribute toward keeping up the temperature.

Digitized by Google

2nd, Force is produced in much the same way as heat, from all the constituentsof the food.

3d, New tissue. There has been much comflicting testimony on the formation of new tissue, the chief difficulty being to find the source of fat. At first, it was held that the animal only sorted out and stored the fat already existing as fat in the food; experiments soon showed that the fat produced by pigs and in the milk of cows largely exceeded that taken into the system in the food. It was then held that the albuminoids might make up the deficiency, or by others, that the albuminoids were the only source of fat. Laws & Gilbert showed, in certain experiments, that they carried on, that not only was there a lack of fat in the food, but that the fat and albuminoids taken together could not produce all the fat that was stored up, and consequently that the starch or sugar of the food *must* have contributed. It may be safely said that the elements from which the animal fats are made up come from the albuminoids, carbohydrates and fat. It is probable that the muscle and other nitrogenous parts of the animal come from the albuminoids of the food. This, however, is not fully concurred in by all physiologists.

The changes which food undergoes in the animal system are very complex, and just how hay, grain, cottonseed, grass, ensilage, etc., are changed into milk, muscle, blood, wool, fat, etc., is a problem which physiological chemistry has not yet definitely solved.

The whole object of this brief discussion of the principles of animal nutrition is to enable us to understand the meaning and use of the *stock feeding tables* which have been prepared for us, and as an intelligent use of these tables cannot fail to improve the methods of feeding too often practiced in our state. I shall try to show just what the tables are and how they are to be used.

PRACTICAL USE OF FEEDING TABLES.

Two questions cover the whole field. 1st: How much food does an animal require? 2nd: How can a ration, which will furnish this amount, be decided upon?

The answer to both comes from the *tables* that will be given later in this *Bulletin*. and, therefore, I will explain what the tables are, and how they were prepared.

Digitized by Google

The knowledge which we have concerning the requirements of various animals, under varying circumstances, comes largely from German scientists, who have devoted much time and monoy to agricultural investigations, their methods of working out the results that we have obtained may be best explained by giving the actual records. The first step is to determine the amount of food actually required to keep a given animal, without gain or loss, this is called a "maintenance ration." From "Armsby's Manual of Cattle Feeding," I select an experiment made by Henneberg and Stohmann. Oxen weighing one thousand pounds were fed on the following rations daily:

	Pounds.		Pounds.		Pounds.	
Experiment 1,	19.5	clover hay.				
" 2,	3.7	"	13.0	oat straw,	0.6	*rape cake.
" 3,	2.6	"	14.2	"	0.5	"
" 4,	3.8	"	13.3	rye straw,	0.6	"
" 5,	25.6	mangolds,	12.6	oat straw,	1.0	"

All of these, except the first, kept the annimals in good health, of a constant live weight, or nearly so. Let us take the third experiment and study it. We have a ration that will keep a one thousand pound ox without loss. This question comes up: What amonnt of albuminoids, carbo-dydrates, and fat, does this furnish? The experimenters analysed the foods and determined the digestibility of each constituent. The following table shows the digestible matter per one hundred pounds of each article used in the test:

100 lbs. of	Albuminoids.	Carbo-hydrates.	Fat.
Clover contains,	6.00	39.5	1.0
Oat straw contains,	.87	45.5	0.30
*Linseed contains,	27.00	28.5	9.00

With this table we can compute the exact amount of digestible matter that the ox received in that ration. This is given below:

	Furnished digestible. Pounds.	Albuminoids. Pounds.	Carbo-hydrates. Pounds.	Fat. Pounds.
Clover,	2.6	0.156	1.02	0.026
Oat straw,	14.2	0.123	6.46	0.042
Linseed,	0.5	0.135	0.14	0.045
Total digestible matter daily,		0.414	7.62	0.113

*This rape cake is of about the came composition as the linseed found in the markets of the United States.

Digitized by Google

Here we have a definite quantity of nutritive matter, that was found capable of supporting an ox, now if from any combination of food we are able to supply this amount of digestable matter we may be tolerably certain, that the results will be satisfactory, for an animal that is standing still in a warm stall. A majority of farmers, however, do not care to feed simply for maintenance. but want growth, or milk, or wool, the same method of investigation has been applied to all cases, cows giving milk were fed on various combinations of such fodders as the German farmers produce, after many trials those rations, which seemed to be best adapted were taken as standard, and when their value was established by enough trials, the food was analysed and the same method of computation applied, as in the case above tabulated. In the same way fattening cattle, horses at work and resting, cows not in milk, growing cattle, swine, etc., have been experimented on and *standard rations* established.

Two tables are necessary in computing rations, one showing what quantity of *albuminoids* and *non-nitrogenous, material*, is required daily by various animals for each one thousand pounds of live weight, the other showing the composition of the digestible part of all the foods that the farmer is likely to have at hand.

In these tables I have carried out the modification explained on page 10.

TABLE B.

FEEDING STANDARD.

Showing digestible substances required daily by the following animals per 1,000 pounds of live weight:

	Digestible substances.		
1,000 lbs. of live weight require daily.	Albuminoids. Lbs.	Carbo-hydrate equivalence. Lbs.	Nutritive ratio.
Oxen, at rest,	0.7	8.37	1:12
Oxen, moderately worked,	1.6	12.05	1: 7.5
Oxen, heavily worked,	2.4	14.45	1: 6
Oxen, fattening,	3.0	16.55	1: 5.5
Cows, giving milk,	2.5	13.50	1: 5.4
Horses, light driving,	1.8	12.70	1: 7
Horses, heavily worked,	2.8	15.4	1: 5.5
Growing cattle,	2.5	15.0	1: 6
Sheep, for wool,	1.2	10.8	1: 9

Digitized by Google

Sheep, fattening,	3.0	16.45	1: 5.5
Swine, fattening,	4.0	24.0	1: 6

TABLE C.

FEEDING STUFFS.

100 lbs. of the following materials contain.	Digestible substances. Albumnioids.	Carbo-hydrate equivalence.	Nutritive ratio.
Herdgrass (timothy) hay,	3.45	48.71	1:14
Redtop hay,	4.74	48.19	1:10
Mixed hay,	3.71	47.61	1:12.8
Mixed hay and clover,	4.85	46.40	1: 9.5
Salt marsh hay,	2.27	45.83	1:20
Clover hay,	7.53	43.60	1: 5.7
Vetch hay,	9.20	37.67	1: 4
Oat hay,	4.85	44.83	1: 9.2
Winter rye hay,	10.3	51.7	1: 5
Millet hay,	4.67	45.43	1: 9.7
Rowen,	6.81	41.74	1: 6.1
Oat straw,	1.45	43.31	1:30
Bean vines,	5.00	36.45	1: 7.3
Corn stover,	2.15	41.38	1:19
Ensilage, (northern corn),	1.47	14.80	1:10
Ensilage, (southern corn),	1.32	12.73	1: 9.6
Ensilage, (sweet corn),	1.84	14.92	1: 8
Pasture grass,	2.5	10.9	1: 4.4
Green rye,	2.00	12.87	1: 6.4
Potatoes,	1.42	17.70	1:12.4
Sugar beets,	1.5	7.81	1: 6.5
Corn and cob meal,	7.13	66.52	1. 9.3
Corn meal,	7.78	71.60	1: 9.2
Barley meal,	9.54	65.95	1: 6.9
Oats, ground,	9.90	58.16	1: 5.9
Buckwheat, ground,	7.7	66.71	1: 8.7
Linseed, (old process),	28.12	53.21	1: 1.9
Linseed, (new process),	28.57	44.30	1: 1.5
Cottonseed meal,	31.36	42.26	1: 1.3
Shorts,	13.26	52.70	1: 4
Middlings,	13.35	57.72	1: 4.3
Gluten,	25.14	61.90	1: 2.4
Brewers' grains, (wet)	4.73	16.22	1: 3.4
Malt sprouts,	18.36	52.18	1: 2.8

Digitized by Google

Cow's milk, (whole),	3.00	14.0	1: 4.6
Skim milk,	3.23	6.94	1: 2.1
Butter miik,	2.9	4.50	1: 1.5

The table above given is made up chiefly from the compilations of Dr. Jenkins, in the 1887 Conn. state report, together with a full special analyses from Goessman, Armsby, and Jordan. The digestion co-efficients were taken from the Mass., state report for 1887, and a few from the American results, obtained by Jordan and Armsby.

With these two tables any farmer can gain a tolerable correct idea of what his live stock require, and also can compound rations which will satisfy these requirements and if from the variety of fodders which are to be found on most farms, together with such grains as are to be had in in the market, a daily ration can be formed which will contain the digestible albuminoids and carbo-hydrate equivalence, shown by table B, to be necessary for a given animal under given conditions, it may reasonably be expected that such a ration will be very satisfactory, I do not, however, wish to be understood as claiming that these tables are absolutely exact, for they evidently cannot be, but they are *guides* to good and economical feeding and when supplemented by good judgement and close observation are sure to give much better results, than can be obtained by good judgment alone. No man can afford to disregard the experience of careful men who have spent a life time in searching for the laws which govern the nutrition of animals, and the man who regards his own limited experience as superior to that of scores who have spent their whole time in studying this difficult problem, stands in his own light because certainly no evil can result from accuracy in feeling, and the chances all favor an improvement by such exactness.

HOW TO USE THE TABLES.

The first difficulty that must be met is that of determining the live weight of the animal to be fed. The following rule though by no means accurate, is of some value in determining this; Ordinary cattle, girting 5 ft, will weigh from 650 to 750 pounds, according to form and fatness; for each additional inch in girth, add 25 pounds, up to 6 ft, and for each inch after 6 ft, add 50 pounds.

Digitized by Google

The following table is constructed on the basis given in above rule, it is not however, claimed that the figures are very close, but I have found them to agree with actual weighing, in a fair proportion of cases, and it is given in this bulletin with the hope that those who have the opportunity will test it and report their results of actual weighing, in this way in time a table can be arranged which will be much better than the present one.

STEERS, OXEN, ETC.

Girth in		Store cattle.—Quality.		Medium fat.—Quality.	
		Fair.	Good.	Fair.	Good.
Ft.	In.	Lbs.	Lbs.	Lbs.	Lbs.
5	0	650	700	700	750
5	1	675	725	725	775
5	2	700	750	750	800
5	3	725	775	775	825
	4	750	800	800	850
	5	775	825	825	875
	6	800	850	850	900
	7	825	875	875	925
	8	850	900	900	950
5	9	875	925	925	975
5	10	900	950	950	1000
5	11	925	975	975	1025
6	0	950	1000	1000	1050
6	1	1000	1050	1050	1100
6	2	1050	1100	1100	1150
6	3	1100	1150	1150	1200
6	4	1150	1200	1200	1250
6	5	1200	1250	1250	1300
6	6	1250	1300	1300	1350
6	7	1300	1350	1350	1400
6	8	1350	1490	1400	1450
6	9	1400	1450	1450	1500
6	10	1450	1500	1500	1550
6	11	1500	1550	1550	1600
7	0	1550	1600	1600	1650
7	1	1600	1650	1650	1700
7	2	1650	1700	1700	1750
7	3	1700	1750	1750	1800
7	4	1750	1800	1800	1850
7	5	1800	1850	1850	1900
7	6	1850	1900	1900	1950

This table will enable those who have had but little experience in weighing, to form some idea of the amount of food required. A few examples will serve to illustrate the method of computing a ration:

Take a cow giving milk, and weighing 900 pounds, turn to table B, and we see that a cow giving milk, and weighing *one thousand* pounds requires to be furnished daily with food enough to contain 2½ pounds of digestable albumenoids, and 13½ pounds of carbo-hydrate equivalents, but the case we have taken does not call for so much, as the cow only weighs 900 pounds, the following proportion is capable of giving the exact amount required.

Digitized by Google

1000 : 900 :: 2.5 : albuminoids required, and

1000 : 900 :: 13.5 : carbo-dydrate equivalence requred.

The first proportion works out as follows: 2.5×900=2250 ÷1000=2.25 lbs.

The second proportion works out as follows: 13.5×900= 12150÷1000=12.15 lbs.

That is, a 900 pound cow requires daily, albuminoids, 2.25 pounds; carbo hydrate equivalence, 12.15 pounds.

How shall we get this amount most economically? almost every farmer has one or more of the following course fodders, straw, corn fodder, bog meadow hay, also English hay, either herdsgrass, red top, or mixed hay, and corn meal; many have ensilage, and on the coast salt hay.

The quantity of English hay, that should be fed daily, when hay is the standard fodder, is from 1 to 1½ per cent of the live weight of the animal, and with it from ½ to ⅔ as much of some course fodder, like straw, or cornfodder, or bog meadow hay, this gives bulk to the ration and is the framework to which the grain ration must be fitted.

Let us see what this framework will furnish, to do this turn to table C, and opposite "mixed hay" and "oat straw" we find that 100 pounds of the former will furnish 3.71 lbs. of digestable albuminoids and 47.61 lbs. carbo-hydrate equivalence, the oat straw, 1.41 lbs. and 43.31 of the same nutrients, consequently.

	Albuminoids.	Carbo-hydrate equi alence.
12½ pounds mixed hay will furnish	0.47 lbs.	5.95 lbs.
5 pounds oat straw will furnish	0.070 lbs.	2.17 lbs.
To this add the followin grain ration:		
3 pounds cotton seed meal will furnish	.94 lbs.	1.26 lbs.
2 pounds shorts will furnish	.27 lbs.	1.05 lbs.
2 pounds middlings will furnish	.27 lbs.	1.15 lbs.
4 pounds corn meal will furnish	.16 lbs.	1.43 lbs.
	2.18	13.01
Required as shown by Table B,	2.25	12.15

This gives a ration near enough for all practical purposes, in finding what quantities of the various constituents are needed, it will usually be necessary to make several trials before the right proportion of albuminoids and carbo-hydrate equivalence

Digitized by Google

is secured, but as a general rule, the more coarse fodder used the greater should be the amount of cottonseed, linseed, gluten or shorts in the grain ration, and the less the amount of corn meal. Now let us see how the hay and straw framework would balance if, as is too often the case, only corn meal is used.

	Albuminoids. Lbs.	Carbo-hydrate equivalence. Lbs.
12½ pounds mixed hay,	0.47	5.95
5 pounds oat straw,	0.07	2.17
5⅔ pounds corn meal,	.44	4.05
Furnished,	0.98	12.17
Required,	2.25	12.15
Deficiency of albuminoids,	1.27	

This ration gives us a sufficient supply of starch, sugar, fat, etc., but less than ½ the required amount of albuminoids, if the German experiments are worth anything, they show that it is poor policy to use corn meal alone as a grain ration, for English hay and coarse fodders. Once more let us see what would result if we take a sufficient quantity of corn meal to get the required amount of albuminoids:

	Albuminoids. Lbs.	Carbo-dydrate equivalence. Lbs.
12½ pounds hay,	0.47	5.95
5 pounds oat stram,	0.07	2.17
22 pounds corn meal,	1.71	15.75
Furnished,	2.25	23.87
Required,	2.25	12.15
Excess of non-nitrogeous matter,		11.72

These two rations show very forcibly that either the practice of feeding corn meal alone, with hay and straw, is a bad one, or the feeding standards are worthless.

It will be noticed, that the proportions given on page —, have 1000 for their first term, this must always be so because the tables are computed for animals weighing 1000 pounds, this being so the determination of what a given animal requires, when its weight is known is very simple.

Rule for determining, the digestible matter required by an animal of *any* weight: *Multiply the number of pounds of albumi-*

Digitized by Google

noids, and carbo hydrate equivalence, found in table B, for the desired condition, in which the animal is, by the live weight and move the decimal point three places to the left.

For example, a steer weighs 1250 lbs., and it is proposed to fatten this animal, what amount of *nutrients*, (that is digestible albuminoids and carbo-hydrate equivalence) are required? In table B, it is seen that, "oxen fattening," require daily 3.0 of albuminoid, and 16.5 pounds of carbo-hydrates and fat per 1000 pounds live weight, applying our rule we get $3 \times 1230 = 3750$; removing the decimal three places gives 3.75 pounds of albuminoids, in the same way, $16.5 \times 1250 = 20625.0$; remove the point three places, $= 20.62$ pounds of carbo-hydrate equivalence required.

To form a trial ration, take 1% of live weight of animals in hay, and 1% in corn fodder, then take about ⅓ of one per cent of one of the following concentrated feeding stuffs, cotton seed, gluten, linseed, or malt sprouts, and ½ the quantity of shorts, and make up the ration with corn meal and middlings, a few trials will give a combination coming close enough to the standards.

	Albuminoids.	Carbo-hydrate equivalence.
12½ pounds of hay,	.46	5.95
12½ pounds of corn stover,	.27	5.11
4½ pounds of cotton seed meal,	1.41	1.90
2¼ pounds of shorts,	.30	1.18
5 pounds of middlings,	.67	2.88
7 pounds of corn meal,	.55	5.01
	3.66	22.09

There are reasons for believing that this ration is fully as economical for the American farmer, as one corresponding exactly with the German standard, our conditions differ from theirs, corn is our standard grain, it is cheaply produced in the West, and must constitute a considerable portion of our rations here and hence a little less of albuminoids, and more of carbo-hydrate eqaivalence must be used. I am satisfied from the feeding experiments, that have been conducted on our college farm, that a considerable variation from the foreign standards may be economical, and that instead of a nutritive ratio of 1 : 5.4 for cows giving milk, we can do better with a ratio of 1 : 6 or 7,

Digitized by Google

this may perhaps be considered a pretty wide variation, but I believe the cheapness which we can produce starchy foods, more than compensates for any loss that may result in quantity or quality of milk from the reduced quantity of albuminoids. The factor of cost of foods has been too much overlooked in American investigations, so that in pointing out the errors of the too common practice of feeding corn meal exclusively, we have tended toward the other extreme.

In the following computed rations the grain rations are given in pounds, and in parentheses are given the quarts and parts of quarts, computed from the following table, which gives the weight of the various grains per half bushel and per quart:

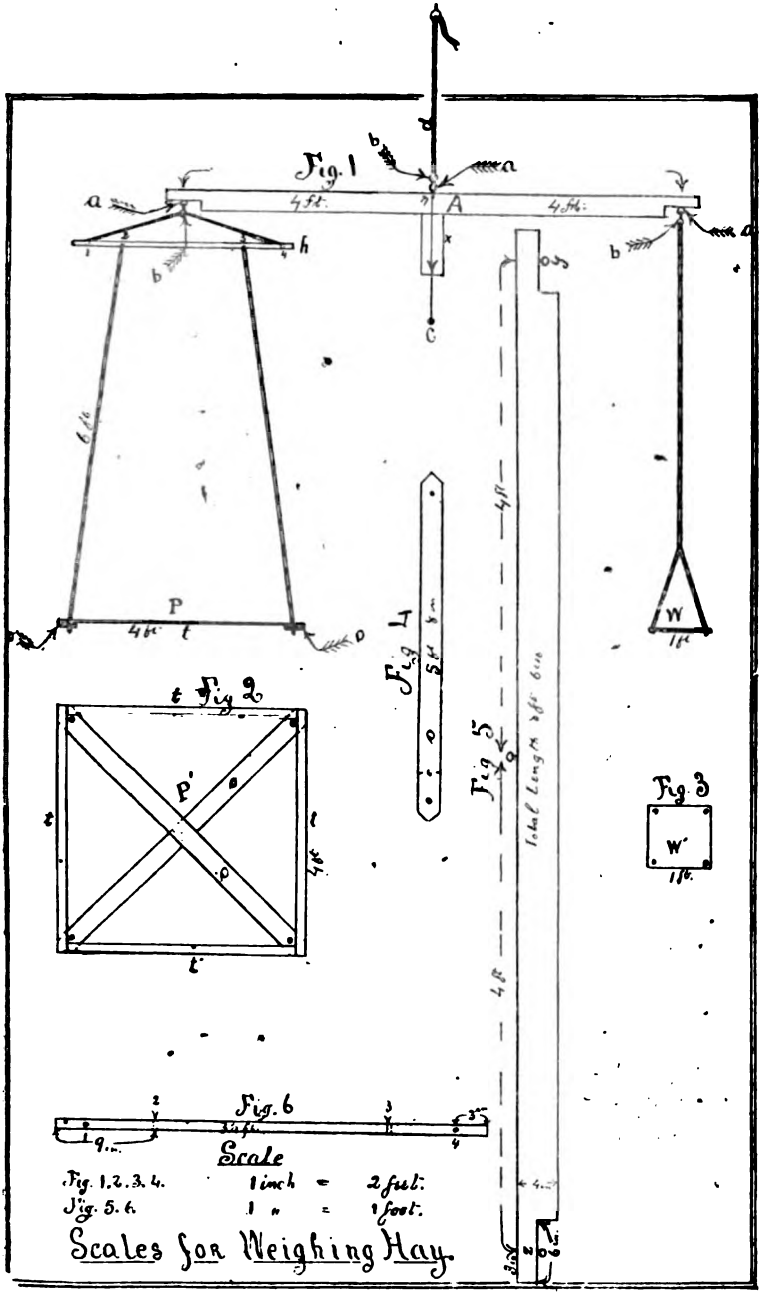
WEIGHT OF GRAINS.

	Weight per ½ bushel. Lbs.	Oz.	Per quart. Lbs.	Oz.
Corn meal,	23	8	1	7
Cotton seed,	25	8	1	9
Shorts,	11	4	0	11
Middlings,	18	0	1	2
Grounds oats,	12	0	0	12
Gluten,	26	0	1	8
Corn and cob meal,	22	0	1	6
Cracked corn,	28	0	1	12
Whole oats,	16	0	1	0

Or stated in another way:

1 pound of corn meal equals	0.7	quarts.
1 pound of cotten seed equals	0.625	"
1 pound of shorts equals	1.43	"
1 pound of middlings equals	0.90	"
1 pound of oats equals	1.33	"
1 pound of gluten equals	0.617	"
1 pound of corn and cob meal equals	.73	"
1 pound of cracked corn equals	.57	"
1 pound of whole oats equals	1.00	"

Digitized by Google



Digitized by Google

It is often difficult for many to weigh hay, corn fodder, straw, etc., for lack of suitable scales, but this is by no means a serious matter, for less than $1.00 outlay of cash and ½ days work, a balance can be made that will weigh very accurately, the cuts on page 23, represent the parts of one that is now in use in our feeding barn. Figure 1, is the complete balance, A is the beam, a, a, a, are the pivots which consist of "screw eyes," b, b, b, and common "halter snaps," which hook into these screw eyes. The cords which suspend the weight platform w and the spreader h pass through two of these "snaps" while the hook or cord by which the whole is suspended from a beam, (d in the cut Fig. 1) is attached to the third "snap." The platform P is suspended by its four corners by cords passing *through* the "speader" h at the parts marked, 2, 3, the "speader" being suspended by the cord shown passing through holes at 1 and 4, c is a plumb bob suspended from near the top of the beam at n, and when balanced should be in the center of the board x that is fastened to the center of the beam.

The material from which to construct such a balance consist of "three screw eyes" and three "halter snaps" these may be had at any hardware store, also 40 ft, of window weight cord and cloth or canvass to cover the hay platform, this is all that need be bought, and the whole cost is only 35 cents.

The beam is made of a straight piece of inch board, 4 inches wide, and 8 ft, 6 inches long, this is shown in Fig. 5, on the under side of this at each end, a piece is cut out, 6 inches long and 2 inches wide as shown, on the *top* side in the *exact center* one screw eye is inserted, now measure *exactly* 4 feet each way from this to the points y, z, Fig. 5, and insert a screw eye at each end on the *under* side, this completes the beam.

Next get out 2 pieces each 1 inch thick, 4 inches wide and 5 ft, 8 inches long, like Fig. 4, and cut the ends as shown; these are the pieces o, o, which cross in Fig. 2; cross them at right angles and nail securely; now take four lath, (t, t, t, t, Fig. 2), cut two of the 4 ft, long, and two 3 ft, 9 inches long. The cross piece o which is *underneath* must have two blocks of inch board, 4 inches square, nailed to each end, to bring the top up even with the other cross-piece. Now nail the lath on as shown. This is the skeleton of the platform which is to be covered with heavy cotton cloth, or canvass, or oil cloth, tacked to the lath

Digitized by Google

frame, ⅜ inch holes are bored, one in each corner, through this the window cord will pass. The "spreader" h, is shown on a larger scale in Fig. 6; it is made from a rake stale and is 3½ ft, long; four holes are bored in this, two (1 and 4 in cut) are 3 inches from the ends, the spreader bail-cord passes through these. The other two are 9 inces from the end and are at *right angles* to the two first mentioned; through these (2 and 3 in Fig. 6), the cords which suspend the platform are to pass.

Fig. 3, is simply a piece of inch board, 1 foot square, with holes in each corner. On this platform the weights are to be put. The cuts show how the cords are arranged; where the spreader bale passes through the halter snap it must be tied so that it cannot slip through the ring of the snap. It is very important that the distance between the center "screw eye" and the end ones shall be *exactly alike.*

When the whole is completed it may be suspended from a beam in the barn floor by a rope, and if it is desirable this rope may pass through a pulley on the beam, and when the balance is not in use it may be *drawn up* out of the way, being lowered on to the floor when needed.

I was three hours in building the one we are using and most farmers or their boys or hired men, can build one without having a carpenter to do the work. The cost will then be less than fifty cents. Surely this sum need not prevent any one knowing what they are feeding.

When the whole is complete two bricks will nearly balance the hay platform. It then becomes necessary to have weights from which various combinations may be made. Two bricks may be selected that will weigh 4 pounds each; another may be broken, thus getting by a little chipping, a 2 pound weight; also a piece can, with a small amount of work, be made to weigh 1 pound. With these, even pounds from 1 to 11 can be made out.

I have just carefully tested the balance we are using and find it sensitive to ½ ounce. The grain rations may be weighed on the same balance or it may be measured. The former is more accurate but not quite as convenient.

The following rations have been adapted, as far as possible to New Hampshire conditions. They are, however, but a few of the possible combinations, but will serve as examples in their respective classes:

Digitized by Google

CLASS I.

RATIONS FOR COWS GIVING MILK, (LIVE WEIGHT, 900 LBS.).

Ration 1.

	Amount. Lbs.	Qts.	Albuminoids. Lbs.	Carbo-hydrate equivalence. Lbs.
Mixed hay,	12½		0.47	5.95
Oat straw,	5		0.07	2.17
Cotton seed meal,	3	(2)	.97	1.26
Shorts,	2	(3)	.27	1.05
Middlings,	2	(1¾)	.27	1.15
Corn meal,	4	(2¾)	.16	1.43
Total daily,		(9½)	2.18	13.01
Required,			2.25	12.15

Ration 2.

Clover hay,	10		.753	4.36
Corn fodder,	10		.215	4.13
Corn meal,	4	(2¾)	.160	1.43
Gluten,	3	(2)	.754	1.85
Shorts,	2	(3)	.265	1.05
Total,		(7¾)	2.147	12.82

Ration 3.

Herdsgrass hay,	10		0.345	4.87
Bog meadow or salt marsh hay,	10		.227	4.58
Corn and cob meal,	5	(3½)	.356	3.32
Cotton seed,	3	(2)	.940	1.26
Shorts,	2	(3)	.270	1.05
Total,		(8½)	2.14	15.08

Ration 4.

Ensilage, (northern corn),	50		0.74	7.40
Mixed hay with clover,	10		.485	4.64
Gluten,	4	(2½)	1.006	2.47
Totals,			2.231	14.51

Ration 5.

Ensilage, (southern corn),	40		0.53	5.08
Oat straw,	8		0.12	3.46

Digitized by Google

Corn and cob meal,	2	(1½)	0.14	1.33
Cotton seed,	3	(2)	0.94	1.26
Shorts,	3	(4¼)	0.40	1.58
Total,		(7¾)	2.13	12.71
	Ration 6.			
Ensilage, (northern),	40		0.590	5.92
Corn stover,	10		0.215	4.13
Corn meal,	2	(1½)	0.156	1.43
Linseed, (new process),	3	( )	0.860	1.32
Middlings,	2½	(2¼)	0.334	1.44
Total,			2.155	14.24
	Ration 7.			
Ensilage, (Sanford corn),	50		.92	7.46
Clover hay,	5		.38	2.18
Bean vines,	5		.25	1.82
*Mixed grain,	4	(3½)	.31	2.86
Total,			1.86	14.32
	Ration 8.			
Ensilage, (northern),	50		.74	7.40
Corn fodder,	6		.13	2.48
Clover hay,	5		.38	2.18
Corn and cob meal,	2	(1½)	.14	1.33
Gluten,	3	(1¾)	.76	1.85
Total,			2.15	15.24
	Ration 9.			
Ensilage, (northern),	50		.74	7.40
Clover,	5		.38	2.18
Corn fodder,	6		.13	2.45
Mixed grain,	4	(3½)	.31	2.86
Buckwheat,	2	(1¾)	.15	1.33
Total,			1.71	16.22
	Ration 10.			
Herdsgrass and red top,	8		.30	3.80
Clover,	5		.38	2.18

*Corn and cob, 90 lbs. + 25 lbs. oats.

Digitized by Google

Millet hay,	6		.28	2.72
Mixed grain,	9½	(8)	.74	6.80
Total,			1.70	15.50

FOR COWS WEIGHING 800 LBS.

Ration 11.

Herdsgrass,	20		.69	9.74
Corn meal,	3	(2)	.23	1.99
Shorts,	1	(1½)	.13	.52
Cotton seed,	2	(1¼)	.63	.84
Total,			1.68	13.09

Ration 12.

Mixed hay,	10		.37	4.76
Cured oats,	10		.48½	4.48
Cotton seed,	2	(1¼)	.63	.84
Shorts,	3	(4½)	.39	1.56
Total,			1.87½	11.64

Ration 13.

Mixed hay,	10		.37	4.76
Cured oats,	10		.48½	4.48
Cotton seed,	2	(1¼)	.63	.84
Shorts,	2	(3)	.26	1.04
Corn meal,	2	(1½)	.15½	1.43
Total,			1.90	12.55

Ration 14.

Herdsgrass,	20		.69	9.74
Cured Oats,	5		.24	2.24
Shorts,	2	(3)	.26	1.04
Middlings,	2	(1¾)	.27	1.15
Corn Meal,	2	(1½)	.15½	1.43
Total,			1.61½	15.60

Rations 7 to 14, inclusive, are rations that have been or are now used in our feeding, and though some of them are a pretty wide departure from the standards, yet they appear to be economical. But it must be remembered that the fodders used have not been analysed, and there is reason to believe that the results in table C are lower than they should be.

Digitized by Google

CLASS II.

RATIONS FOR FATTENING CATTLE WEIGHING 900 LBS.

Ration 15.

	Amount. Lbs.	Qts.	Albuminoids. Lbs.	Carbo-hydrate equivalence. Lbs.
Mixed hay,	12½		.47	5.95
Oat straw,	7½		.11	3.25
Corn and cob meal,	5	(3½)	.36	3.32
Cotton seed,	4	(2½)	1.25	1.69
Ground oats,	3	(4)	.30	1.74
Total furnished,			2.49	15.95
Total required from Table B,			2.70	14.90

CATTLE OF 1000 LBS., LIVE WEIGHT.

Ration 16.

Clover hay.	10		.75	4.36
Oat straw,	5		.07	2.16
Bean vines,	5		.25	1.82
Corn and cob meal,	5	(3¾)	.36	3.32
Cotton seed meal,	5	(3)	1.57	2.11
Ground oats,	4	(5⅓)	.40	2.33
Total,			3.40	16.10
Required,			3.00	16.55

WEIGHING 900 LBS.

Ration 17.

Mixed hay,	10		.37	4.76
Corn fodder,	13		.28	5.37
Corn and cob meal,	5½	(4)	.39	3.65
Cotton seed meal,	5	(3)	1.57	2.11
Total,			2.61	15.89

WEIGHING 1000 LBS.

Ration 18.

Mixed hay,	5		.18	2.38
Ensilage, (northern),	50		.74	7.40
Cotton seed,	5	(3)	1.57	2.11
Corn and cob meal,	5½	(4)	.39	3.65
Middlings,	1	(1)	.13	.58
Total,			3.01	16.12

Digitized by Google

	Ration 19.			
Ensilage,	50		.74	7.40
Bog meadow or salt marsh hay,	10		.23	4.58
Gluten,	6	(3¾)	1.51	3.71
Corn meal,	5	(3½)	.39	3.58
Total,			2.87	19.27

CLASS III.

WORKING OXEN, WEIGHT 1500 LBS. EACH.

	Ration 20.			
Mixed hay,	25		.93	11.90
Corn meal,	5	(3½)	.39	3.58
Middlings,	5	(4½)	.67	2.88
Cotton seed,	2	(1¼)	.33	.84
Total,			2.32	19.20
Required,			2.40	18.07
	Ration 21.			
Mixed hay,	10		.37	4.76
Corn fodder,	10		.22	4.14
Ensilage,	25		.33	3.18
Corn meal,	7	(5)	.54	5.01
Linseed, (new process),	3	( )	.86	1.33
Total,			2.32	18.42
	Ration 22.			
Mixed hay with clover,	20		.97	9.28
Corn fodder,	10		.22	4.14
Corn meal,	8	(5½)	.57	5.32
Middlings,	4	(3½)	.54	2.30
Total,			2.30	21.04

CLASS IV.

HORSES, (HEAVILY WORKED), WEIGHT 1000 LBS.

	Ration 23.			
Herdsgrass hay,	20		.69	9.54
Cracked corn,	4	(2¼)	.29	2.66
Whole oats,	12	(12)	1.19	6.97
Total,			2.17	19.17
Required,			2.80	15.40

Digitized by Google

Ration 24.

Mixed hay,	20		.74	9.52
Whole oats,	10	(10)	.99	5.87
Linseed,	2	( )	.57	.88
Corn meal,	2	(1½)	.14	1.33
Total,			2.44	17.60

CLASS V.

HORSES, (LIGHT WORKED), WEIGHT 1000 LBS.

Ration 25.

Mixed hay,	10		.37	4.76
Oats,	6	(6)	.60	3.49
Corn meal,	5	(3½)	.39	3.58
Shorts,	2	(3)	.27	1.05
			1.63	12.88
			1.80	12.70

G. H. WHITCHER, *Director.*

The Bulletins of this Station are sent *free* to all farmers in the State who request the same.

G. H. WHITCHER.

Digitized by Google

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION.

HANOVER, N. H.,

BULLETIN NO. 5.

FERTILIZERS AND FERTILIZING MATERIALS.

MARCH, 1889.

Digitized by Google

HARVARD COLLEGE
FEB 21 1929
LIBRARY

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

BOARD OF CONTROL:

Hon. Warren Brown, President,	Hampton Falls.
Hon. S. B. Whittemore,	Colebrook.
Hon. G. A. Wason,	Nashua.
Prof. G. H. Whitcher, Secretary,	Hanover.

OFFICERS:

G. H. Whitcher,	Director.
A. H. Wood,	Supt. Dairy Dept.
H. H. Lamson,	Microscopist and Photographer.
F. W. Morse,	Chemist.
C. L. Parsons,	Asst. Chemist.
C. H. Pettee,	Meterologist.
J. M. Fuller,	Station Farmer.
H. L. Barnard,	Clerk.

Digitized by Google

FERTILIZERS.

Probably eighty per cent of all inquiries addressed to the Experiment Station relate to either the use of fertilizer or to stock feeding. Recognizing this fact a *Bulletin* (No. 4) was issued at the beginning of the winter. It will soon be time for the use of fertilizers; next year's crops must be fed, and they in turn will feed the farm stock of 1889–90, therefore, we must, even before the present winter stock feeding ends, commence, indirectly, the next winter's feeding. The first stages, however, does not deal with albuminoids, starch, sugar, oil, etc., but with the elements of which these are made up.

Plants, no less than animals, require food; they create nothing, but simply take the compounds which exist in the air and in the soil and by unknown chemical processes build up starch, sugar, cellulose, vegetable acids, oils, albuminoids, etc. This power belongs exclusively to plants; animals are unable to transform the elements of water and carbonic acid into starch and glucose, or any other organic compound.

If plants must be fed it follows that we must have food upon which to feed them. This we call *plant food.*

To know what plants require we must know what they are made up of. Chemical analysis alone is able to take apart the substance of a plant and tell us what it is composed of. A stalk of corn weighing five pounds, or eighty ounces, was analysed at the Agricultural College Laboratory and found to contain:

		Ounces.
Water,		65.15
Albuminoids,		1.51
Fat,		47
Carbohydrates,	Cane sugar,	4.80
	Glucose,	80
	Starch, etc.,	2.79
	Fiber,	3.65
Ash,		.83
	Total,	80.00

Digitized by Google

retary of the Board of Agriculture. and the Secretary of the Dairyman's Association.

2. Seventy-five pounds of milk will be used by each system Tuesday morning, Jan. 8, and seventy-five pounds by each system, Tuesday night; each test will, therefore, consist of one hundred and fifty pounds of milk.

3. The cans used by each competing manufacturer shall be their usual cans, used in the common way; the hand power separator shall be the DeLaval vertical, run at not less than forty, nor more than forty six. turns a minute.

4. The temperature of the milk, which shall all be of the milking corresponding with the time of setting or separating, may be anywhere from 70° to 90°, as each system may desire.

5. All milk will set twenty-four hours in water at any temperature desired, from 40 up, and the skimming will be by the surface skimmer of the Moseley and Stoddard and the bottom skimming device of the Cooley, and all others, in like manner, by their common advertised method. The milk will be run through the hand separator as soon as the whole milk is divided into three parts, a sufficient quantity of the skim milk being poured back and run again, to displace the cream in the bowl.

6. The "separated" cream will be held in ice water until Wednesday night, as will the first skimming from the deep setting; Wednesday night, when the last skimming is done, all the cream from each system will be warmed to 85° and will stand in the same rooms at a temperature as near 65° as is possible; it will be regularly and equally stirred at such times as may be agreed upon until it is time to put it in the churn.

7. Churning will commence as near 8 A.M, Thursday the 10th, as possible, and, as each lot will be churned in the same churn, lots will be drawn to determine the order of churning.

The temperature of the cream will be such as each representative of the respective systems shall decide upon within 58° to 68° and the churning shall proceed at such rate of speed as is desired by each; the butter-milk shall be removed by washing, as far as is possible, and the butter, after being washed in the churn, shall hang in a cheese cloth bag twenty minutes, it shall then be weighed, and for each pound one ounce of saltshall be added; it shall then be worked by some experienced butter maker on a Skinner worker; said butter maker

Digitized by Google

shall not know the identity of the samples and shall work them as uniformly as he can.

The salted butter shall then be weighed and samples be taken for analysis.

Samples of milk, skim-milk, and butter-milk shall also be taken, and shall be analysed.

8. The final award of merit shall rest upon the basis of the per cent of *actual fat*, (as determined by analysis of the milk, and the weight of the milk) *that is recovered* in the butter; (also determined by analysis of the butter.) To make this clear, I will give an example. Suppose the milk to contain 4% of *fat* 150 lbs. × .04=6.00 lbs. actual fat Suppose this to make 6¼ lbs. of butter containing 80% of fat, 6.25×.80=5 lbs. of fat in butter; that is, out of six pounds of fat in the milk five have been recovered in the butter or 83⅓% of the total fat of the milk is found in the butter; this represents the efficiency of the system used.

The quality of the butter from each system will also be determined by an expert."

The committee conducted the tests without mishap in any part of the work.

The Johnson Top Can Separator, a new device for raising cream by cold deep setting, was not in working shape as only half the necessary number of cans were brought, and consequently one setting stood but nine hours and the other but thirteen and a half, this renders it impossible to compare the results of this system with the others. I have given the figures however.

The work of mixing, and dividing the milk was done with the greatest of care. The order of taking out the night's setting being the reverse of the morning's, so that all danger of getting richer milk at the top might be avoided, since the system that took the *top* milk in the morning took the bottom milk at night.

The Centrifugal Separator used was run by hand power, and of course did not skim as thoroughly as the larger machines that run by steam power.

Table I gives the following details of the work.

The amount of milk, the temperature at which it was when set, the temperature of the water in which it was set, the time

Digitized by Google

that] elapsed before skimming, the spaces of cream, and the weight of the same, the time required for churning, temperature of cream when churned, the amount of skim-milk and the fat in it as shown by analysis.

TABLE I.

			MILK.				CREAM.			SKIM-MILK.		BUTTER-MILK.	BUTTER.						
			Amount set.	Temperature of milk.	Temperature of water at time of setting.	Temperature of water when skimmed	Time milk set.	Spaces.	Amount.	Time required to churn.	Temperature when churned.	Amount.	Per cent. of fat in	Amount.	Per cent. of fat in	Amount.	Per cent. of fat in	Per cent. of casein in	Per cent. of water in	Quality, 100 being perfect.	Efficiency of system.	Milk required per pound of butter.
			lbs.	deg.	deg.	deg.	h'rs.		lbs.	min.	deg.	lbs.		lbs.		lbs. oz						lbs.
Moseley & Stoddard,	1	A. M.	75	90	40	32	24	26	34	31	62½	57	0.34	2.17	27¾	6 ¼	80.89	0.46	14.07	89	89.11	24.8
		P. M.	75	91	40	33	21	26½					0.28									
Cooley,	2	A. M.	75	90	40	32	23½	21½	33¾	28	65	58¾	0.27	3.29	26½	5 14	81.25	0.38	15.01	85	80.86	25.5
		P. M.	75	91	42	35	21½	21					0.22									
Johnson top can,	3	A. M.	48	90	40	32	9		21	17	65	36	0.29	5.53	17	3 5½	78.00	0.66	16.40	86		
		P. M.	48	91	42	35	13½					38	0.32									
Shallow six quart pans,	4	A. M.	143¾	90	55	55	29¾		26¾	33	60	115¼	0.19	1.07	20	6 4	82.32	0.66	12.58	95	91.07	23
		P. M.			47	50							0.50									
DeLaval hand separator,	5	A. M.	75	87			*17		17½	22	61	65¾	0.48	.99	11	6 13	79.44	0.49	14.02	86	91.10	22
		P. M.	75	87			17					65	0.39									
													0.46									
													0.26									
													0.21									

*Time of separating, in minutes.

Digitized by Google

The amount of butter-milk, (this was determined by subtracting from the weight of cream the weight of the drained butter, this is the most accurate method, for it is impossible to draw off all the butter-milk and weigh it, as a portion will be left in the butter and must be worked or washed out,) the % of fat in the butter-milk, the % of water, fat, and casein in the butter, the amount of butter, its quality as determined by experts who knew nothing of the identity of the samples, the efficiency of the systems and the pounds of milk required per pound of butter.

The committee of experts who examined the butter consisted of C. H. Waterhouse President of the New England Creamery Association, and H. W. Sadd of Connecticut.

The butter was marked in the following scale for perfect butter: Flavor, 50, Grain, 25, Color, 15, Salt 10.

Table II gives the full marking of each sample.

	Perfect butter would mark:	Moseley and Stoddard.	Cooley.	Johnson top can.	Shallow six quart pan.	DeLaval hand separator.
Flavor,	50	40	43	50	45	41
Grain,	25	25	20	18	25	25
Color,	15	14	12	8	15	10
Salt,	10	10	10	10	10	10
Total,	100	89	85	86	95	86

The efficiency of the various sytems is based upon the per cent of the total fat in the milk which is found in the butter, (See rule 8 of "Rules of Test") this was taken because it is the only true test. If one system gives a cream which churns less thoroughly than the cream given by another system, it is just as much to the discredit of the former as though the fat was left in the skim-milk, consequently if we are to arrive at a knowledge of the value of any given system we must follow the original fat in the milk through to the lump of butter, and find the per cent of this fat that is recovered.

Of the fat not recovered in the butter, the greater the part of it that is left in the skim-milk, and the less the part left in the butter-milk the better, because of the fact that skim-milk is in better shape to feed to calves than butter.milk. First get as

Digitized by Google

large a per cent of the total fat as possible into the butter, second, of the portion not recovered get as little as possible in the butter-milk.

The milk used in these tests was sampled and analyzed. Morning's milk had 3.93% of fat, night's milk 3.99% of fat.

The following table shows the amount of fat in the milk, the amount lost in the skim-milk and butter-milk and the amount recovered in the butter:

	Moseley and Stoddard. lbs.	Cooley. lbs.	Open pans. lbs.	Separator. lbs.
Total fat in milk,	5.9400	5.9400	5.6500	5.9400
Lost in skim-milk,	.3246	.3094	.3976	.4315
Lost in butter-milk,	.6020	.8718	.2140	.1089
Recovered in butter,	4.8776	4.7734	5.1450	5.4118
	per cent.	per cent.	per cent.	
Per cent of Total fat lost in skim-milk,	5.47	5.21	7.03	7.26
Per cent of Total fat lost in butter-milk,	10.13	14.67	3.78	1.83
Per cent of Total fat recovered in Butter,	82.11	80.36	91.07	91.10

If perfect work could be done and if there was such a thing as absolute accuracy. the sum of the fat in butter, skim-milk and butter-milk would equal the total fat in the milk used, but there are small errors in weighing, and in chemical analysis and sampling which are unavoidable. Every chemist recognizes certain limits of error in his work; every investigator realizes that weighings made with standard scales are imperfect; as a result we find just what would be expected, namely, that the sum of the fat in butter, skim-milk and butter-milk in each system does not correspond exactly with the fat in the milk, but if we take the four lots it appears that we had, in the milk used 23.47 pounds of fat and there is accounted for 23.46 pounds, an error of less than one-sixth of an ounce, hence we may reasonably conclude that these errors, as a whole, balance.

The figures are so plain that comment is unnecessary, and so far as one test conducted by competent and careful men can be relied upon we may place the Separator first, the Open pans second, the Moseley and Stoddard third, and the Cooley last, in point of efficiency.

Digitized by Google

HOW THE CREAM WAS RIPENED.

The separated cream was at once placed in water and surrounded with ice the temperature being kept at about 34°, the first skimmings of the milk that was set was also kept in ice water, and at this temperature no appreciable amount of "ripening" could have taken place. The shallow pans were not skimmed until 4 p. m., Wednesday, the temperature of the room varying from 47° to 55°.

At 6:36 p. m. Wednesday all the cream was removed from ice water and warmed up to 85° and set in a room, the temperature of which was 63°, here it remained until 10:30 a. m., Thursday, it had, therefore, sixteen hours in which to ripen. It is a well known fact that cream at 85° ripens much faster than cream at 60°, hence the time allowed for ripening was not uncommonly short, but, on the contrary, was well up to that allowed in most creameries, and, while there is no absolute standard by which degrees of "ripeness" may be determined, I have no doubt that the cream used in these tests was as well ripened in 16 hours after being warmed to 85° as it would have been in 24 hours at 62°. This was carefully considered when "Rule 6" was framed, for it was known that 24 hours could not be allowed, consequently the higher temperature was introduced to compensate for the lack of time. The circumstances were such that two and one half hours additional time was given more than Rule 7 calls for, it is only fair to suppose, therefore, that the cream was of average ripeness.

Lots were drawn to determine the order of churning, the Shallow pans were first, Stoddard second, Separator third, Cooley fourth, Johnson fifth. Two Stoddard churns were secured so that with the Shallow pans and the Stoddard cream, churning commenced at 10:48 a. m., Thursday, with the Separator and Cooley at 12:3 p. m., and with the Johnson at 1:16 p. m.

TEST OF CHURNS.

There being a lack of time in which to make the churning tests, it was decided to have these carried on by the Station employees and the representatives of the Moseley and Stoddard, and Blanchard churns consented to leave their goods for the work.

Digitized by Google

Mr. A. H. Wood Supt. Dairy work, has carried out the following experiments, the chemical work being done by Mr. E. H. Farrington.

The cream for each test was kept in one vat and ripened and then divided into three lots.

The cream for the first tried was held thirty hours and was *sweet.* The second trial was the same, but the third was warmed up to 70° and allowed to stand until it gradually fell to 55°, it was again warmed and in all stood thirty hours, it was slightly acid.

TABLE II.

	DAVIS.			BLANCHARD.			STODDARD.		
	First trial	Sec'd trial.	Third trial.	First trial.	Sec'd trial.	Third trial.	First trial.	Sec'd trial.	Third trial.
Amount of cream, lbs.,	42	47.4	39	42	47.4	39	42	47.4	39
Time of churning, min.,	19½	28½	24½	44	53½	43½	24	32½	30½
Temperature of cream, deg.,	62	61	62½	62	61	62½	62	61	62½
Amount salted butter, lbs.,	13.0	14.81	12.00	13.34	15.69	12.09	12.75	15.09	12.69
Amount buttermilk, lbs.,	27	31	26½	27	31	26½	27	31	26½
Per cent of fat in buttermilk,	2.14	1.19	2.02	2.61	1.26	1.94	2.30	1.24	1.82
Per cent of fat in butter,	——	85.16	82.84	——	79.07	82.70	——	83.46	79.43
Total fat in butter, lbs.,	——	12.61	9.94	——	12.41	10.00	——	12.6	10.08
Total fat in buttermilk, lbs.,	——	.38	.53	——	.40	.51	——	.40	.48
Speed of churn, per min.,	45	45	45	60	65	65	60	65	65

The table given above shows the details of each trial for each churn.

The butter from the first trial was not analyzed, but the butter-milk was and as the thoroughness of churning is shown by the per cent of fat left in the butter-milk, the work is not injured by the absence of the butter analysis in this case.

The following table gives the per cent of fat in the butter-milk from each churn for each trial, and also the average of the three trials.

BUTTER MILK.

	Analysis of.			
	1st trial.	2nd trial.	3d trial.	Average.
Davis,	2.14	1.19	2.02	1.78
Blanchard,	2.61	1.26	1.94	1.93
Stoddard.	2.30	1.24	1.82	1.78

In the three trials 128.4 pounds of cream was used by each system, with the following results:

Davis swing, made 39.81 pounds of salted butter.
Blanchard, made, 41.12 pounds of salted butter.
Stoddard, made, 40.53 pounds of salted butter.

Digitized by Google

Taking the last two trials where analyses of both butter and butter-milk was made, and we found that from 86.9 pounds of cream the

Davis made,	26.81 pounds of salted butter.
Blanchard made,	27.78 pounds of salted butter.
Stoddard made,	27.78 pounds of salted butter.

From the analyses of the butter, we find that each of the foregoing amounts of butter, had of *actual butter fat* the following:

Davis, 22.55 lbs. of fat; lost in butter-milk, 0.91 lbs.
Blanchard, 22.41 lbs. of fat; lost in butter-milk, 0.91 lbs.
Stoddard, 22.68 lbs. of fat; lost in butter-milk, 0.88 lbs.

The total fat in both butter and butter-milk being:

Davis, 23.46 lbs.; 96.1 per cent. of this was in the butter.
Blanchard, 23.32 lbs.; 96.1 per cent. of this was in the butter.
Stoddard, 23.56 lbs.; 96.2 per cent. of this was in the butter.

These results show that there is practically no difference in the efficiency of these three churns and if there is any prefference it must come from convenience in handling, and ease of operation; on this point there is no doubt in the mind of those who have actually operated the churns here at the Station, for ease of handling and cleaning, and for perfection of granulation of butter the Stoddard churn stands at the head. The Blanchard is open to the objection that it has inside floats, which interfere seriously with the granulating of the butter. The Davis is harder to operate than either of the others, and is more difficult to clean when the churning is done. The average time of churning was twenty four minutes for the Davis, forty-seven minutes for the Blanchard and twenty-nine minutes for the Stoddard. The Davis leads in point of time required.

BUTTER EXHIBIT.

The following letter was sent to each creamery in the State, so far as the address was known:

"A three days Farmer's Institute is to be held here Jan. 8–9–10. The third day will be under the control of the Granite State Dairymans Association and we are very anxious to have a good exhibit of butter and cheese and want you to favor us with a five pound box of your butter.

Digitized by Google

This butter will all be tested by an expert butter tester and will be sampled, and the samples analyzed free of expense at the Experiment Station Laboratory. This will give very valuable information to all butter makers, and it is especially desirable that we get samples of all the creamery butter in the State.

Yours truly G. W. WHITCHER."

Private dairymen were also invited to send samples.

As a result fourteen Creameries sent twenty-two samples, and eleven private dairies sent twenty-four samples. The following is the full list of butter that was examined by Mr. H. K. Slayton of Manchester. The first, second and third awards in each class being indicated.

"S" indicates Separator, "C," Cooley.

Name of creamery.	Location.	Station No. of sample.	
West Lebanon, S,	West Lebanon,	A–109	1st
West Lebanon, S,	West Lebanon,	A–110	
West Lebanon, S,	West Lebanon,	A–111	
C. G. Britton, C,	Keene,	A–102	2nd
Hanover, S,	Hanover,	A–101	3rd
L. T. Hazen, S,	Whitefield,	A–105	
Lyme, S,	Lyme,	A–100	
Oyster River, C,	Durham,	A–104	
Cornish, S,	Cornish,	A–106	
Alstead, C,	Alstead,	A–107	
Cold Brook, C,	Franklin,	A–103	
Cold Brook, C	Franklin,	A–118	
Piermont, S,	Piermont,	A–108	
Short Falls, S,	Epsom,	A–112	
Center Strafford, S,	Strafford,	A–113	
Center Strafford, S,	Strafford,	A–114	
Center Strafford, S,	Strafford,	A–115	
Center Strafford, S,	Strafford,	A–116	
Center Strafford, S,	Strafford,	A–117	
E. M. Smith, C,	Peterborough,	A–119	
E. M. Smith, C,	Peterborough,	A–120	
Grantham, C,	Grantham,	A–121	

PRIVATE DAIRY.

Name.	Location.	System usrd.	Station No.
J. F. Johnson,	Norwich, Vt.,	Cooley,	B–100

Digitized by Google

Name.	Location.	System used.	Station No.	
J. F. Johnson,	Norwich, Vt.,	Cooley,	B–101	
E. A. Perley,	Lebanon,	Cooley.	B–102	
L. T. Hazen,	Whitefield,	Separator,	B–103	2nd
J. L. Gerrish,	Webster,	Milk set in tin sap pails,	B–104	
W. D. Baker,	Quincy,	Lincoln Channel Cans,	B–115	
W. D. Baker,	Quincy,	Lincoln Channel Cans,	B–116	1st
W. D. Baker,	Quincy,	Lincoln Channel Cans,	B–117	
W. D. Baker,	Quincy,	Lincoln Channel Cans,	B–117	
W. D. Baker,	Quincy,	Lincoln Channel Cans,	B–118	
Exp. Station,	Hanover,	Separator,	B–105	3d
Exp. Station,	Hanover,	Separator,	B–106	
Exp. Station,	Hanover,	Separator,	B–107	
Exp. Station,	Hanover,	Separator,	B–108	
Exp. Station,	Hanover,	Separator,	B–109	
Exp. Station,	Hanover,	Separater,	B–110	
Exp. Station,	Hanover,	Separator,	B–111	
Exp. Station,	Hanover,	Separator,	B–112	
Mr. Fairbanks,	Hanover,	Ferguson,	B–113	
Mr. Fairbanks,	Hanover,	Ferguson,	B–114	
C. W. Emery,	Canterbury,	Woosters creamer,	B–119	
C. W. Emery,	Canterbury,	Woosters creamer,	B–120	
F. Little,	Peterborough,	(?)	B–121	
A. O. Smith,	Peterborough,	(?)	B–122	

The following is the description of the method used in making the butters that were awarded first, second and third places in each class.

CREAMERY.

First Award. West Lebanon Creamery Co-operative, milk gathering, mixed milk from Jersey and native cows, run through DeLaval Separator, cream ripened twenty hours as near 62° as possible, churned in Blanchard Box churn at 64°, butter washed in granular form with water at 55°, Higgins salt, Wells, Richardson & Co., butter color, Blanchard butter worker used.

Digitized by Google

This sample was taken from a lot of 450 pounds churned at one time.

Signed J. H. BICKFORD, Butter-maker.

Second Award. C. G. Britton's proprietary Creamery, milk from mixed breeds set in Cooley Creamer, cream ripened eighteen hours at 66° and churned at 65° in Davis churn, washed when in granular form in water at about 50°, Lever worker used, Genesee salt and Fletcher's butter color used.

Signed C. G. Butler, Keene, N. H.

Third Award. Hanover Creamery Co-operative, milk gathering, milk from mixed breeds, run through DeLaval Separator, cream ripened about twenty-four hours at about 60°, churned in Blanchard churn, washed when in granular form in water at 60°, worked with Blanchard worker, salted with Higgins salt and colored with Hansens butter color.

Signed Henry Cummings, butter-maker.

PRIVATE DAIRY.

First Award. W. D. Baker. Milk from Holstein-Jersey cross, set in Lincoln Channel Can creamer, cream ripened twelve hours at 75°, one quart of butter-milk was added to the cream to assist in ripening, churning was done in Davis churn, cream at a temperature of 66°, worked in granular form in water at 50°. No color used.

Signed W. D. Baker.

Second Award. L. T. Hazen. Milk from Jersey cows, run through DeLaval Separator, cream ripened thirty-six hours, and churned at 62° in Box churn, washed in granular form with water at 50°, Ashtons salt and Hansens butter color used.

Signed L. T. Hazen.

Third Award New Hampshire Experiment Station. Milk from Jersey cows, run through DeLaval Hand power Separator, cream ripened twenty-four hours at 65°, churned in Stoddard churn at 62°, washed in granular form in water at 52°, worked on Skinner worker, Higgins salt and Hansens butter color used.

Signed A. H. Wood, Supt. Dairy Dept

Samples were taken from each lot of creamery butter and from part of the private dairy butter, these were analized at the

Digitized by Google

Station Laboratory, the per cent. of water, fat, and casein, being determined, the salt etc. is found by difference.

The volatile fatty acids are also given, these are determined by a process in which a definite amount of the pure butter fat is converted into soap by a solution of potash, to which alcohol is added, after this the alcohol is driven off by heat, then water and a solution of phosphoric acid are added and the mixture distilled until a given amount is collected. This distilate contains the volatile acids, this is neutralized with a solution of soda of known strength, and the figures given show the number of parts of this soda solution required to neutralize the acids. This test is much used in detecting adulteration or in distinguishing oleomargarine from pure butter.

Table III gives the full analysis of each sample. By some error the casein was not determined in the sample made at the Experiment Station.

TABLE III.

Name of exhibitor.	No. of sample.	Per ct. water.	Per ct. fat.	Volatile acids =c. c. soda solution.	Casein.	Salt, etc., by difference.
Lyme creamery,	A100	13.08	81.98	15.3	.756	4.18
Hanover creamery, 3d prize,	A101	11.24	85.07	15.3	.544	3.15
Keene creamery, 2nd prize,	A102	11.33	84.39	15.2	.700	3.58
Cold Brook creamery, Franklin,	A103	7.60	88.49	14.8	.576	3.33
Oyster River creamery, Durham,	A104	9.19	85.74	15.5	.781	4.29
Island View creamery, Whitefield,	A105	14.37	80.32	14.5	.560	4.75
Cornish creamery,	A106	15.70	79.87	15.5	.960	3.47
Cold River creamery, Alstead,	A107	8.51	87.86	14.6	.743	2.89
Piermont creamery,	A108	13.22	81.21	15.8	.697	4.98
West Lebanon creamery, 1st prize,	A109	12.69	82.15	15.4	.650	4.51
Short Falls creamery,	A112	14.94	82.45	14.6	.706	1.91
Center Strafford creamery,	A113	10.00	87.30	14.7	.377	2.32
Cold Brook creamery, print,	A118	11.90	82 35	15.8	.669	5.18
Peterboro creamery,	A119	12.26	83.77	15.3	.631	3.34
Grantham creamery,	A121	9.41	86.26	14.7	.650	3.68
E. A. Perley, dairy, Lebanon,	B102	12.15	85.40	15.0	.545	1.91
L. T. Hazen, dairy, Whitefield, 2nd,	B103	11.86	82.85	16.1	.925	4.37
J. L. Gerrish, dairy, Mast Yard,	B104	8.08	85.19	15.1	.756	5.98
W. D. Baker, Quincy, 1st,	B110	8.43	81.10	15.8	.669	2.80
N. H. Exp't Station, Hanover, 3d,	B105	10.12	85.32	15.5	(?)	(?)
Averages,		11.30	84.30	15.2	.678	3.66

The averages in the above table must closely correspond with the average of the best butter made in the State. For the sake of comparison I have collected data which gives the following general average composition of many samples of butter: Water 12.48; Fat 84.77; Casein .73; Salt etc. 2.02; volatile acids=to 14 c.c. standard soda solution.

Digitized by Google

The butter exhibited show a large per cent. of salt, but this is demanded by the customers as a general thing. The casein is low but there is possibility of improvement here, we should try to produce butter in our creameries with not over .5 of one per cent. of casein, the per cent. of water too should be reduced, and the fat correspondingly increased.

If I were to give a standard for creameries or private dairymen to work toward. It would be as follows: Water 10 per cent; Fat 86 per cent; Casein 0.5; Salt 3.5; fancy butter as a rule runs high in the per cent. of fat, high in volatile acids, low in water and casein.

In conclusion I would especially call the attention of the dairy farmer to the importance of these and similar tests as a means of improving the methods of manufacture, and the quality of the product. Dairying is fast becoming the mainstay of New Hampshire agriculture, and there is need of following every improvement, and to my mind, there is no way in which the Experiment Station can render greater aid than by conducting careful tests, and reporting results.

G. H. WHITCHER, *Director.*

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION,

HANOVER N. H.,

BULLETIN NO. 8.

FEEDING EXPERIMENTS.

PART 1.—PRINCIPLES OF FEEDING.

PART 2.—CORN MEAL, MIDDLINGS, SHORTS AND COTTON SEED COMPARED.

NOVEMBER, 1889.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

BOARD OF CONTROL:

Hon. Warren Brown, President,	Hampton Falls.
Rev. S. C. Bartlett. LL.D.,	Hanover.
Prof. G. H. Whitcher, Secretary,	Hanover.
Hon. S. B. Whittemore,	Colebrook.
Hon. G. A. Wason,	Nashua.

OFFICERS:

G. H. Whitcher,	Director.
A. H. Wood,	Supt. Dairy Dept.
H. H. Lamson,	Microscopist and Photographer.
F. W. Morse,	Chemist.
C. L. Parsons,	Asst. Chemist.
C. H. Pettee,	Meteorologist.
J. M. Fuller,	Station Farmer.
C. W. Whitcher,	Clerk.

Digitized by Google

FEEDING EXPERIMENTS.

PART I.

The object of this bulletin is to place in the hands of the New Hampshire farmer, a brief statement of some of the experiments made during the winter of 1888-9, for the purpose of determing the the feeding value of various fodders and grains, in the production of milk and butter, and as the period of winter feeding is at hand, I have thought best to give in condensed form, the principles and laws which are at the bottom of successful, practical stock feeding showing how these laws find expression in which are called "Feeding Standard.' The tables given are a reprint of those in Bulletin No. 4 of this station; Their use though exceedingly simple, is, nevertheless a key to successful practical feeding, and no farmer in the state who has stock to feed can afford to neglect the teachings of these tables for by their use the cost of production of milk, on an average, may, in my opinion, be reduced one fifth from the present figures any such estimate must be a matter of opinion but it is true in all lines of manufacture that the substitution of exact, in place of hap-hazard methods, of demonstrated laws instead of guesses, invariably reduces the cost of the manufactured article, and the production of milk beef or pork is no exception to this.

Rational methods in stock feeding depend upon two things. First, we must know what a given animal requires daily. Second, we must have some means of knowing where and how to get these materials in the right quantity and proportion. These two requirements are satisfied by tables I and II.

WHAT THE TABLES ARE

Table I, called "Feeding Standards," tells us at a glance how much digestible material is *required* daily for 1000 lbs. live weight for the various animals under the several conditions mentioned. This table originated in Germany and represents the average of a great number of carefully conducted practical tests in which the food was weighed, and samples of it analysed and its digestibility determined. It is very reasonable to suppose that these results are, in the main, reliable and accurate,

Digitized by Google

TABLE I. GERMAN "FEEDING STANDARDS."

1,000 lbs. of live weight required daily.	Digestible substances. Albuminoids. lbs.	Non-albuminoids. lbs.	Nutritive ratio.
Oxen, at rest,	0.7	8.37	1:12
Oxen, moderately worked,	1.6	12.05	1: 7.5
Oxen, heavily worked,	2.4	14.45	1: 6
Oxen fattening,	3.0	16.55	1: 5.5
Cows, giving milk,	2.5	13.50	1: 5.4
Horses, light driving,	1.8	12.70	1: 7
Horses, heavily worked,	2.8	15.4	1: 5.5
Growing cattle,	2.5	15.0	1: 6
Sheep, for wool,	1.2	10.8	1: 9
Sheep, fattening,	3.0	16.45	1: 5.5
Swine, fattening,	4.0	24.0	1: 6

TABLE II. COMPOSITION OF "FEEDING STUFFS."

Herdsgrass, (timothy) hay	3.45	48.71	1:14
Redtop hay,	4.74	48.19	1:10
Mixed hay,	3.71	47.61	1:12.8
Mixed hay and clover,	4.85	46.40	1: 9.5
Salt marsh hay,	2.27	45.83	1:20
Clover hay,	7.53	43.60	1: 5.7
Vetch hay,	9.20	37.67	1: 4
Oat hay,	4.85	44.83	1: 9.2
Winter rye hay,	10.3	51.7	1: 5
Millet hay,	4.67	45.43	1: 9.7
Rowen,	6.81	41.74	1: 6.1
Oat straw,	1.45	43.31	1:30
Bean vines,	5.00	36.45	1: 7.3
Corn stover,	2.15	41.38	1:19
Ensilage, (northern corn),	1.47	14.80	1:10
Ensilage, (southern corn),	1.32	12.73	1: 9.6
Ensilage, (sweet corn),	1.84	14.92	1: 8
Pasture grass,	2.5	10.9	1: 4.4
Green rye,	2.00	12.87	1: 6.4
Potatoes,	1.42	17.70	1:12.4
Sugar beets,	1.5	7.81	1: 6.5
Corn and cob meal,	7.13	66.52	1: 9.3
Corn meal,	7.78	71.60	1: 9.2
Barley meal,	9.54	65.95	1: 6.9
Oats, ground,	9.90	58.16	1: 5.9
Buckwheat, ground,	7.7	66.71	1: 8.7
Linseed, (old process),	28.12	53.21	1: 1.9
Linseed, (new process),	28.57	44.30	1: 1.5
Cotton seed meal,	31.36	42.26	1: 1.3
Shorts,	13.26	52.70	1: 4
Middlings,	13.35	57.72	1: 4.3
Gluten,	25.14	61.90	1: 2.4
Brewers' grains, (wet)	4.73	16.22	1: 3.4
Malt sprouts,	18.36	52.18	1: 2.8

Digitized by Google

that variations from them are some times profitable is well known and from the work that has been done in our own country it would seem that the proportion of non-albuminoids (starch, sugar; fat etc.,) to albuminoids might well be made less than the tables indicate,' but the fact that we may depart in a small way from these tables does not in the least reduce their value as *guides* to *good feeding.*

The column headed *digestible albuminoids* includes that part of the food which contains the nitrogen of the plant. It will be noticed that the per cent of albuminoids vary greatly in different fodders. In *dry* fodders, oat straw has only 1.45 pounds in a hundred while cottonseed meal has 31.36. Hay and the dry fodders commonly found on the farm have about 5% of digestible albuminoids while the grains and concentrated feeding stuffs run from 7 to 35%. It must be remembered that this part of the food is very valuable, for the muscle of the growing animal, the casein or curd of the milk, wool, feathers, hair, etc., must be formed from the albuminolds of the food. Neither starch, sugar nor oil can be converted into muscle or casein by the animal. It is also believed that the fat in the milk or the other fat in the body comes quite largely from the albuminoids, but fat may also come from the starch, sugar, and oil of the food. The column marked "digestible non-albuminoids" includes the starch, sugar, and fiber, plus the fat, multiplied by 2½, for it is assumed that one pound of fat is equal in nutritive value to 2½ pounds of starch, by this arrangement we get the whole of the nutritive matter of the food grouped in two parts. The third column shows the ratio of non-albuminoids to albuminoids for example corn meal has 7.78% of albuminoids and 71.6% of non-albuminoids the "nutritive ratio" is 1 : 9.2 which is the same as saying that for every pound of the former. there are 9.2 pounds of starch, sugar, and fat (non-albuminoids).

In these tables then we have the means of finding the amount of nutritive matter require daily by any animal; the live weight of any animal being known we have only to look in table I, and find the corresponding kind of animal, the table will show what would be required if the live weight were 1000 lbs., from this we find the amount necessary for any weight by multiplying that necessary for 1000 by the weight under consideration and remove the decimal point three places to the left. Example: Given a cow weighing 1185 pounds, and producing milk

Digitized by Google

what amount of albuminoids and non-albuminoids will be required daily? Table I, shows that cows giving milk require 2.5 lbs., of albuminoids and 13.5 lbs., of non albuminoids daily per 1000 lbs., 2.5 × 1185= 2962.5 remove point three places to the left = 2.96 lbs., of albuminoids required. 13.5 × 1185 = 15997.5 remove point three places = 15.99 lbs., non-albuminoids required. The same rule applied under any condition or for any weight will give "amount required."

The second step is to select from table II such fodders and grains as will give this amount, here is where the skill of the feeder is required in selecting a suitable variety. If hay is the foundation use 1½% of the live weight of the animal of hay, that is for a 1000 lb., animal use about 15 lbs.. of hay, and in addition to this 1% or 10 lbs., of any coarse fodder like corn stover (corn stalks from which ears have been husked) well cured straw, rye cut for fodder, millet, or bean vines.

Where Ensilage is to be fed, take 5% of the live weight of the animal of Ensilage that is for a 1000 lb., animal, 50 lbs., and add to this ½% or 5 lbs,, of coarse fodder, these two combinations may be regarded as foundations to which the grain ration is to be fitted. Our coarse fodders, hay and ensilage, all with two or three exceptions, contain much too large a percentage of non-albuminoids to meet the requirements of cows. Oat straw has 30 lbs., of digestible non albuminoids to 1 of albuminoids, (see third column table II) cornfodder has a "nutritive ratio" of 19, bog meadow, or swale hay 20. Hedrsgrass 14, red top 10, millet 9.7 etc., now from table I, we see, leaving out animals standing idle, that our different domesticated animals require from 5.4 to 9 pounds of non-albuminoids to 1 of albuminoids, here is where the tables show us the deficiency of such fodders; To make good this deficiency we must look for some material that has an *excess* of the *albuminoids;* running down column three in table II, linseed, cotton seed, shorts, middlings and gluten are seen to have nutritive ratios as follows respectively, 1.5, 1.3, 4, 4.3, 2.4 now here are a class of foods as much too rich in the muscle producing part of the food as the coarse fodders and hay are too poor hence a judicious mixture of one set with the other will correct the deficiencies of each but how shall we know the proportion in which to mix them. We have seen that a cow weighing 1000 lbs. giving milk requires daily the following:

Digitized by Google

Digestible Albuminoids, 2.50 lbs.,
Digestible Non-albuminoids, 13.50 lbs.,

We will next see what our two "foundations" furnish, from Table II it is easily figured that:

	Digestible. Albuminoids. lbs.	Non-albuminoids. lbs.
15 lbs., mixed hay and clover, furnish,	.56	7.14
10 bs corn stover, furnish,	.22	4.14
Total furnished,	.78	11.28
Total required,	2.50	13.50
Deficiency to come from grain,	1.72	2.22

The following will give a ration near enough to the standard.

Cottonseed 4 lbs., = 3 qts., =	1.26	1.68
Shorts, 2 lbs., = 3 qts., =	.26	1.04
Middlings, 1 lb., = 1 qt., =	.13	.57
	1.65	3.29

Putting this ration together we get the following:

	lbs.	qts.	Albuminoids	Non-albuminoids
Hay,	15		56	7.14
Corn stover,	10		22	4.14
Cottonseed,	4	2½	1.26	1.68
Shorts,	2	3	.26	1.04
Middlings,	1	1	.13	.57
	7	6½	2.43	14.57
Required by standard,			2.50	13.50

This ration has a nutritive ratio of 1:6 which is as narrow as we can afford to go.

Our second "foundation" figures as follows:

	lbs.	qts.	Albuminoids.	Non-albuminoids.
Ensilage,	50		.74	7.40
Millet,	5		.23	2.27
Gluten,	2	3	.75	1.85
Middlings,	4	3½	.54	2.30
Shorts,	1	1½	.13	.52
			2.39	14.34

Computing and balancing rations by the aid of the tables requires nothing but simple arithmetical calculations, which any feeder in the state can make if he will and while many will find that by years of observation in the barn they have hit upon

Digitized by Google

rations which the use of these tables cannot better, yet the probability is that three-fourths would find by a very few minutes of figuring that they have been feeding too much of the non-albuminoids, in many cases the nutritive ratio is as wide as 1 : 12. As a rule we are too liberal in our use of corn meal which in itself is lacking in albuminoids, but which is too often fed with foods much more deficient in this same direction.

If the foundation of our rations for milk was clover hay, then we might well depend upon corn meal for our grain ration, but with fodders whose nutritive ratio is from 10 to 20, that is, has 10 to 20 times as much digestible starch, sugar, fat etc., as of albuminoids, it is poor economy to buy corn meal when there are so many kinds of fodders in the market, like cotton seed, gluten, linseed, middlings and shorts, which are rich in just those parts in which the hay, ensilage, corn fodder, etc., are lacking. If the farmers of this state would buy less corn meal and more of the foods above mentioned a considerable saving might be brought about in the cost of the ration, for the reason that with these foods much of the straw, swale hay and other coarse fodders might be substituted in place of the English hay which it is now necessary to feed. By way of illustrating this I will give two rations, which will show the force of what has been said

No. 1.

	lbs.	qts.	Albuminoids	Non-albuminoids
Mixed hay,	25		.93	11.9
Corn meal,	6	8	.48	4.2
			1.41	16.1
Required by German standard,			2.50	13.5

No. 2.

Mixed hay,	10		.37	4.76
Swale hay,	10		.22	4.58
Cotton seed,	4	3	1.26	1.68
Shorts,	2	3	.26	1.04
Middlings,	3	2½	.40	1.73
Furnished,			2.51	13.79
Required by German standard,			2.50	13.50

If we call the average value of market hay in New Hampshire $15, per ton Swale hay $8. Cottonseed $25, Corn meal $20, Middlings $22, and Shorts $20 ration No. 1, will cost 25 cents while No. 2 will cost 22 cents, now it will be seen at once that No. 2

Digitized by Google

furnishes a full ration, with the parts well proportioned for milk production while No. 1 is lacking in albuminoids by more than one pound but has an excess of non-albuminoids, the nutritive ratio of No. 1 is 1 : 11.4 while No. 2 is 1 :5.5. It is evident that the second ration is much better adapted for milk production than the first and would undoubtedly give a better yield.

I would call the attention of our stock feeders, to the one point of *feeding well proportioned or "balanced" rations*, and in this connection, would suggest that the "feeding standards" and table of "Feeding stuffs" are guides which if followed will give this suitable proportion of parts in the rations we feed our stock, now if any one is already feeding such a ration the satisfaction of knowing this will amply repay the little trouble there is in calculating the exact amount of nutritive matter fed; if, on the other hand the present practice does not, within reasonable limits, correspond with the German standards, then no harm can come from modifying the grain or fodder and noting whether there is actually any increase of product or decrease of cost for it is by this measure of dollars and cents that we must finally prove that one ration is better than another.

I have intimated that some variation from the German standard is even desirable in our practice and I am of the opinion that if we get the "nutritive ratio" any where between 6 and 7 we shall still have a well balanced ration.

PART II.

CHEMICAL ANALYSIS OF MATERIALS USED IN FEEDING EXPERIMENTS, WINTER OF 1888–89.

These analyses were made by Mr. F. W. Morse, now Station Chemist. The grains were bought in local markets and the hay was raised on the Station farm.

The analyses show the per cent of water, dry substance, ash, crude protein, nitrogen free extract, (including starch, sugar etc.,) ether extract, or crude fat, and crude fiber; the column showing this is headed "% in original substance." The next column shows the same computed as per cents of the dry substance instead of the original substance next comes per cent of digestible matter in the original substance, this is dervied from the total composition by taking the average digestibility of similiar foods as given by Goessman and others.* This column shows just how

*Massachusetts Agricultural Experiment Station, Annual Report 1887.

Digitized by Google

much useful material there is in each substance, for it is the *digestible* part of the food that determines its value for feeding

TABLE III. EARLY CUT HAY. (Cut July 10, 1888.)

	Total composition.		Amount digestible in original substance.	Digestible.		Nutritive ratio.
	Original substance.	Dry substance		Albuminoids.	Non-albuminoids.	
Moisture at 212°,	12.10					
Dry substance,	87.90					
Crude ash,	3.59	4.09				
Crude protein,	7.19	8.18	4.10	4.10	48.45	1:11.8
Nitrogen free extract,	49.14	55.90	30.95			
Crude fiber,	25.70	29.24	14.90			
Ether extract,	2.28	2.59	1.04			
LATE CUT HAY. (Cut July 31, 1888.)						
Moisture at 212°,	8.63					
Dry substance,	91.37					
Crude ash,	4.34	4.75				
Crude protein,	7.68	7.75	4.04	4.04	50.34	1:12.4
Nitrogen free extract,	50.83	55.63	32.02			
Crude fiber,	26.56	29.07	15.40			
Ether extract,	2.56	2.80	1.17			
CORN MEAL.						
Moisture at 212°	13.90					
Dry substance,	86.10					
Crude ash,	1.50					
Crude protein,	10.17	11.81	8.64	8.64	72.94	1: 8.4
Nitrogen free extract,	68.37	79.40	64.26			
Crude fiber,	1.81	2.10	.61			
Ether extract,	4.25	4.94	3.23			
MIDDLINGS.						
Moisture at 212°,	12.47					
Dry substance,	87.53					
Crude ash,	3.33	3.81				
Crude protein,	19.96	22.81	17.56	17.56	52.86	1: 3
Nitrogen free extract,	57.17	65.30	45.73			
Crude fiber,	3.89	4.45	.78			
Ether extract,	3.18	3.63	2.54			
SHORTS.						
Moisture as 212°,	12.29					
Dry substance,	87.71					
Crude ash,	6.21	7.08				
Crude protein,	17.85	20.35	15.71	15.71	50.74	1: 3.2
Nitrogen free extract,	49.97	56.97	39.97			
Crude fiber,	9.21	10.50	1.84			
Ether extract,	4.47	5.10	3.57			
COTTON SEED MEAL.						
Moisture at 212°,	8.86					
Dry substance,	91.14					
Pure ash,	5.81	6.39				
Crude protein,	46.32	50.82	34.27	34.27	39.70	1: .9
Nitrogen free extract,	23.68	25.97	10 89			
Crude fiber,	6.38	7.00	1.46			
Ether extract,	8.95	9.82	8.14			
GLUTEN.						
Moisture at 212°,	10.52					
Dry substance,	89.48					
Ash,	.70					
Crude protein,	29.70	33.20	25 24	25.24	58.21	1: 2.3
Nitrogen free extract,	54.90	61 34	51 60			
Crude fiber,	.81	.91	.21			
Ether extract,	3.37	3.77	2.56			

Digitized by Google

purposes; The next column gives this same digestible matter grouped into albuminoids, and non albuminoids. The early and late cut hay were nearly clear Timothy or Herdsgrass the former cut July 10 just as it was going out of bloom the latter cut July 31, the seed being well filled but not hard; it must be remembered that the season of '88 was very wet and grass was from 8 to 10 days behind its ordinary time of blooming and maturity.

It will be noticed that these analyses vary in some cases from those of similiar foods in table II but the variations are not very wide. The following table shows in condensed form the analyses above given in detail.

	Digestible Substance		
	Albuminoids	Non-albuminoids	Nutritive Ratio.
Early cut hay (Timothy),	4.10	48.45	1 : 11.8
Late cut hay (Timothy),	4.04	50.34	1 : 12.4
Corn meal,	8.64	72.94	1 : 8.4
Middlings,	17.56	52.86	1 : 3.0
Shorts,	15.71	50.74	1 : 3.2
Cotton seed meal,	34.27	32.70	1 : 0.9
Gluten,	25.24	58.21	1 : 2.3

Table IV gives the full details of an experiment comparing corn meal, cotton seed meal, and shorts. The rations in each case were richer in albuminoids than is believed to be necessary, but it will be noticed that those in which corn meal is used are in strict accord with the "German Standards," and that the substitution of cotton seed for corn meal reduced the ratio from 5.5 to 4.5 on an average, which is a very narrow ratio. The object of this experiment was to determine, if possible, whether an increase in albuminoids would increase the yield of milk. Table IV shows the number of the period and the number of days in each period, as well as the dates. The name of the cow and her breed is given in the left hand column, next comes the kind of food used in the ration, and in the third column the amount of each substance fed daily, together with the nutritive ratio of the food, while at the bottom of this column is the amount of milk produced per period and per day; the fourth, fifth and sixth columns are repetitions of the third, except that changes from corn meal to cotton seed, and the reverse, occur; next comes the total milk for each cow for the *whole* time she was in the experiment, followed by two colums dividing this total into two parts, one produced while *corn meal* was fed, the

Digitized by Google

TABLE IV.

		PERIOD. 14 Mar. 11 to Mar. 25.	15 Mar. 25 to Apr. 8.	16 Apr. 8 to Apr. 22.	17 Apr. 22 to May 6.					Per day.	Nutritive ratio
		lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
Northboro Belle. (Holstein.)	Ensilage,	60	60	60	60	Milk produced "corn meal" periods,		779.8		27.82	
	Rye Hay,	5	5	5	5	Milk produced "cotton seed meal" periods,		724.8		25.86	
						Daily excess in favor of co ton seed meal,				1.96	
	Shorts,	2	2	2	2		Albu-	Non-			
	Corn Meal,	2	2	2		Rations contained.	minoids.	Albu'ds.	Total.		
	Cotton Seed Meal,		2		2	Corn meal ration,	2.90	16.27	19.17		1 : 5 6
	Gluten,	4	4	4	4	Cotton seed ra ion,	3.41	15.46	18.87		1 : 4.5
	Milk per period,	408.13	363.56	371.72	361.29						
	Milk per day,	29.15	25.97	26.55	25.81						
Duchess. (Durham.)	Ensilage,		50	50		Milk produced "corn meal" periods,		149.56		10.68	
	Rye hay,		5	5		Mild produced "cotton seed meal" periods,		151.64		10.83	
						Daily excess in favor of cotton seed meal,				.15	
	Shorts,		2	2			Albu-	Non-			
	Corn Meal,		2			Rations contained.	minoids.	Albu'ds.	Total.		
	Cotton Seed Meal,			2		Corn meal ration,	2.75	14.79	17.54		1 : 5.4
	Gluten,		4	4		Cotton seed ration,	3.26	13.98	17.24		1 : 4.3
	Milk per period,		149.56	151.64							
	Milk per day,		10.68	10.83							
Colinka. (Holstein.)	Ensilage,			60	60	Milk produced "corn meal" periods,		188.68		13.48	
	Rye hay,			10	10	Milk produced "cotton seed meal" periods,		189.50		13.54	
						Daily excess in favor of cotton seed meal,				.06	
	Shorts,			2	2		Albu-	Non-			
	Corn Meal,			2		Rations contained.	minoids.	Albu'ds.	Total.		
	Cotton Seed Meal,				2	Corn meal ration,	3.42	18.85	22.27		1 : 5.5
	Gluten,			4	4	Cotton seed meal,	3.93	18.05	21.98		1 : 4.6
	Milk per period,			188.68	189.50						
	Milk per day,			13.48	13.54						

Digitized by Google

TABLE IV.—(Continued.)

		PERIOD.									
		14 Mar. 11 to Mar. 25.	15 Mar. 25 to Apr. 8.	16 Apr. 8 to Apr. 22.	17 Apr. 22 to May 6.					Per day.	Nutritive ratio
		lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
Marame. (Holstein.)	Ensilage,		60	60		Milk produced "corn meal" periods,		422.24		30.16	
	Rye hay,		5	5		Milk produced "cotton seed meal" periods,		456.99		32.69	
						Daily excess in favor of cotton seed,				2.48	
	Shorts,		3	3			Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,		2	2		Rations contained.					
	Cotton Seed Meal,		2			Corn meal ration,	2.80	16.19	18.99		1 : 5.8
	Gluten,		3	3		Cotton seed ration,	3.31	15.39	18.70		1 : 4.6
	Milk per period,		456.99	422.24							
	Milk per day,		32.04	30.16							
Gleam. (Holstein.)	Ensilage,			50	50	Milk produced "corn meal" periods,		369.67		26.41	
	Rye hay,			5	5	Milk produced "cotton seed meal" periods,		390.13		27.87	
						Daily excess in favor of cotton seed,				1.46	
	Shorts,			2	2		Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,			2		Rations contained.					
	Cotton Seed Meal,				2	Corn meal rations,	2.75	14.79	17.54		1 : 5.4
	Gluten,			4	4	Cotton seed rations,	3.26	13.98	17.24		1 : 4.3
	Milk per period,			369.67	390.13						
	Milk per day,			26.41	27.87						
Catonos Pink. (Jersey.)	Early cut hay,			15	15	Milk produced "corn meal" periods,		142.38		10.17	
	Rye hay,			5	5	Milk produced "shorts" periods,		139.43		9.95	
						Daily excess in favor of corn meal,				.22	
	Shorts,			2			Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,			2	4	Rations contained.					
	Gluten,			2	2	Corn meal ration,	1.98	14.09	16.07		1 : 7.1
	Milk per period,			139.43	142.38	Shorts ration,	2.13	13.65	15.78		1 : 6.4
	Milk per day,			9.95	10.17						
Princess Leto. (Jersey.)	Ensilage.	45	45	45	45	Milk produced "corn meal" periods,		507.07		18.11	
	Hay,	5	5	5	5	Milk produced "shorts" periods,		494.36		17.65	
						Daily excess in favor of corn meal,				.46	
	Shorts,		2	2			Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,	2			2	Rations contained.					
	Gluten,	3½	3½	3½	3½	Corn meal ration,	1.92	12.67	14.59		1 : 6.6
	Milk per period,	256.50	247.73	246.63	250.57	Shorts ration,	2.06	12.22	14.28		1 : 5.9
	Milk per day,	18.32	17.69	17.62	17.90						

Digitized by Google

other while *cotton seed* was in the ration; the last two columns show the gain of milk occasioned by changing from one grain to the other. When the corn meal gives the greatest yield the excess is put in column marked "corn meal," and when cotton seed meal gives best results the gain is found in the column headed "cotton seed meal."

These five cows, when on corn meal, produced daily 108.55 pounds of milk, and when on cotton seed 110.74, a gain of 2.19 pounds, which is .44 of a pound per cow per day. This is too small an amount to be of any great value in getting at the relative efficiency of the two rations, but it will be noticed that in only one case is there an excess on the corn meal side, while in two cases there is practically no difference, the two remaining cows showing a very substantial increase due to the cotton seed.

There is another point which should be considered, though no definite correction can be applied. In four cases the corn preceded the cotton seed, and in one case (that of Maramee) the cotton seed came first, and as all of the cows were naturally shrinking in milk yield, it follows, that in four cases the cotton seed is shown at a disadvantage equal to this shrinkage, while in one case the corn meal loses in the same way. Northboro Belle unquestionably did better on the corn meal than on the cotton seed, while Maramee and Gleam gave evidence just the opposite.

The total digestible matter, that is, the sum of the Albuminoids and non-albuminoids, is somewhat less in the cotton seed than in the corn meal ration; the average for the five cows is 18.81 pounds daily with cotton seed, and 19.10 pounds with corn meal, but it is also true that as the market averages the cotton seed ration costs about three mills more per day than the other. Taking all the facts as they stand, the following conclusions seem warranted:

First. Narrowing the nutritive ratio from the German standard of 5.4 to 4.5 does not *materially* increase the amount of milk.

Second. It appears that under the conditions of the experiment, a *pound of digestible matter* was slightly more efficient in the narrow than in the wide ration.

Third. We must not lose sight of the fact that the manure from the cotton seed ration must have been more valuable, for the reason that corn meal contains only one-half as much phosphoric acid, one-third as much potash, and one-third as much

Digitized by Google

nitrogen, as does cotton seed meal. This becomes an important matter when we consider the field work as well as our feeding.

CORN MEAL COMPARED WITH SHORTS.

From this table it is seen that the two cows produced daily, when on the corn meal ration, 28.28 pounds, and on the shorts, 27.60 pounds, a gain of .68 of a pound in favor of corn meal, or .34 of a pound for each cow. The dry matter in the rations is slightly less with the shorts than with the other, while the cost of the ration is the same. In this experiment the cow Pink was giving a very uniform quantity of milk and had been shrinking very little for two months, while Princess Leto was so fed that the shrinkage, provided it was uniform from period to period, would not work to the disadvantage of either ration; it is probable, therefore, that the shorts were actually of less feeding value than the meal.

TABLE V.

		PART 1.			PART 2.		
		*9 Dec. 24 to Jan. 14.	10 Jan. 14 to Jan. 28.	11 Jan. 28 to Feb. 11.	16 Apr 8 to Apr. 22.	17 Apr. 22. to May 6.	†18 May 6 to May 13.
Nora 2nd. (Durham.)	Early hay,	25	25	25			
	Ensilage,				50	50	50
	Corn Meal,	2	2	2	2	2	2
	Middlings,	2	2	2	2	2	2
	Shorts,	2					
	Gluten,	3	3	3	3	3	3
		587.03	387.27	379.07	332.25	326.09	161.51
		27.95	27.66	27.08	23.73	23.29	23.07

*Period 9 was of 21 days instead of 14. †Period 18 was for 7 days instead of 14.

The experiment recorded in table V must be divided into two parts, as there was an interval of four periods devoted to other work with the same cow.

Part 1, 21 days on *shorts*, the yield was 587.03, or 27.95 daily.
Part 1, 28 " *middlings*, " 766.34, or 27.37 "

Daily excess in favor of shorts, .58

Part 2, 14 days on *middlings*, the yield was 332,25, or 23.73 daily.
Part 2, 21 " *shorts*, " 487.60, or 23.22 "

Daily excess in favor of middlings, .51

Or averaging the two parts, the middlings gave 25.55 "
The shorts gave 25.58 "

The composition of the two rations was:

		Albuminoids.	Non-Albuminoids.	Total.	Nutritive ratio.
Shorts,	Part 1,	2.27	16.58	18.85	1 : 7.3
Middlings,		2.30	16.61	18.91	1 : 7.2

Digitized by Google

		Albuminoids.	Non-Albuminoids.	Total.	Nutritive ratio.
Shorts,	Part 2,	1.98	11.62	13.60	1 : 5.9
Middlings,	Part 2,	2.02	11.65	13.67	1 : 5.7

This experiment shows, like the other, that a change of grain, so long as there is no wide departure in the digestible matter, does not materially affect the results, and as the above rations were compounded, the shorts are as effective as the middlings, but the cost is less by about one-cent daily with the shorts.

GLUTEN COMPARED WITH MIDDLINGS.

A single experiment with *gluten* and *middlings* resulted as follows:

NORA 2ND. (Durham.)

Late cut hay,	20	20
Cured oats,	5	5
Corn meal,	2	2
Middlings,	2	
Gluten,		2⅛
Shorts,	2	2
Milk per day,	25.59	27.62
Dry matter in ration,	17.71	18.07
Nutritive ratio,	1 : 8.4	1 : 7.7

In this case there is an unmistakable gain in favor of the gluten meal. The amount used was such that the cost of the rations was identical.

GLUTEN COMPARED WITH SHORTS.

COUNTESS GAZELLE. (Jersey.)

Hay,	20	20
Corn meal,	2	2
Shorts,	2	
Gluten,	2	3½
Milk per day,	18.71	19.47
Dry matter in ration,	15.49	15.41
Nutritive ratio,	1 : 7.6	1 : 7.2

As in the last case the cost of these two rations is the same, but it will be seen that the gluten is the more efficient, and this, too, against the natural shrinkage of the yield, for in each case the gluten was fed last.

The change in nutritive ratio is not great, but it will be noticed that the results, so far as they go, would seem to indicate

Digitized by Google

that the middlings and shorts rations, with a ratio of 8.4 and 7.6, respectively, were too wide, and that narrowing them to 7.7 and 7.2, though not a great change, is, nevertheless, one that has resulted in a considerable increase of milk, and we may well ask the question whether we can afford to go beyond 7 as the widest limit. I am inclined to think that we cannot.

In conclusion, then, the following conclusions may be drawn:

First. That with rations, whose nutritive ratio is below 1 : 7, it makes very little difference whether we use cotton seed, shorts, middlings or corn meal, so far as milk is concerned, but if we consider the value of the manure the grains will be valued in the order in which they stand.

Second. When the nutritive ratio is wider than 1 : 7.5 a substantial gain may be expected by substituting some grain that will narrow this ration.

Third. A nutritive ration of 1 : 7 is as wide as we can profitably use.

I am convinced from these, and other experiments, that the *proportion and amount* of digestible constituents in the ration is of more importance than the *source* of these constituents, and that the cost of the grain must be the factor that will influence the feeder.

Once more let me urge every farmer to note what he is feeding, both in kind and amount, and then from table II compute the digestible nutritive matter consumed daily and compare this with table I. If it is found that the ratio of non albuminoids to albuminoids is very wide, that is, over 7.5, then a few easily made experiments, in which either cotton seed, gluten, middlings or shorts is substituted for corn meal, will enable any one to determine whether a closer following of the German "standards" will be profitable. There can be no loss result from testing this important matter, and valuable information may be obtained.

G. H. WHITCHER, *Director.*

The Bulletins of this Station are free to all farmers in the State who send a request for them to the Director.

Digitized by Google

Digitized by Google

N. A. Sec. 2 Files
NEW HAMPSHIRE Sci 1636.35

AGRICULTURAL EXPERIMENT STATION,

HANOVER, N. H.

BULLETIN No. 9.

EFFECT OF FOOD UPON MILK:

(a.) Changes due to Breed and Individual Characteristics.

(b.) Changes due to Other Causes aside from Food.

(c.) Changes due to Changed Food.

FEBRUARY, 1890.

MONTPELIER, VT.:
PRINTED BY THE WATCHMAN PUBLISHING COMPANY.
1890.

Digitized by Google

FEB 21 1929
LIBRARY

ORGANIZATION

—OF THE—

NEW HAMPSHIRE

Agricultural Experiment Station.

BOARD OF CONTROL:

Hon. Warren Brown, President,	Hampton Falls.
Rev. S. C. Bartlett, LL.D.,	Hanover.
Hon. S. B. Whittemore,	Colebrook.
Hon. G. A. Wason,	Nashua.
Prof. G. H. Whitcher, Secretary,	Hanover.

OFFICERS:

G. H. Whitcher,	Director.
A. H. Wood,	Supt. Dairy Dept.
H. H. Lamson,	Microscopist and Photographer.
F. W. Morse,	Chemist.
C. L. Parsons,	Asst. Chemist.
C. H. Pettee,	Meteorologist.
J. M. Fuller,	Station Farmer.
C. W. Whitcher,	Clerk.

Digitized by Google

EFFECT OF FOOD UPON THE QUALITY OF MILK.

WHAT IS MILK?

This question is an old one, but nevertheless no complete answer has been given to it, nor can one be given to-day. Certain things are known to be true concerning milk, and from the works of physiologists, chemists and microscopists we are able to give something of an answer to this question. We may study milk in two ways, with the microscope, and with the apparatus of the chemist.

1st. How does milk appear when viewed under the microscope? Not as a simple white fluid as it does to the naked eye, but as a fluid in which are floating countless millions of little spherical particles; these are the *fat globules*, little droplets of pure butter fat. These vary very much in size, both in individuals and among breeds; the average figures resulting from measurements of our four breeds, namely: Jersey, Holstein, Ayrshire and Shorthorn, have been found to be about one eight-thousandth of an inch. If we would get some idea of how small a particle this is, let us remember that such a globule under a microscope magnifying 500 diameters would appear one sixteenth of an inch in diameter, while a common lead pencil magnified the same number of times would appear fifteen feet in diameter; or, if we should desire to lay a row of these little particles of fat across the squared end of the pencil, it would require 2,500 of them, or to cover the entire surface of the pencil end would require 4,900,000 globules.

That the globules vary in size has already been alluded to. Globules are found that are only one forty-thousandth of an inch in diameter, and others one twenty-five-hundredth of an inch.

THE CHEMICAL COMPOSITION OF MILK.

The common method of analyzing milk, separates the sample into five parts, namely: water, fat, caseine, sugar and ash. This composition varies greatly, both among individual animals of the same breed, and also the averages of breeds. I have selected two animals, one a Jersey, the other a Shorthorn, to show the variation of each constituent of the milk, and also have given the average per cent. of fat in the milk of each cow, as well as the fat in the milk of each breed.

Digitized by Google

COMPOSITION OF MILK.	JERSEY.	SHORTHORN.	AVERAGE OF ALL KINDS OF MILK.
	PER CENT.	PER CENT.	PER CENT.
Water,	84.10	87.00	87.00
Solids,	15.90	13.00	13.00
	100.00	100.00	100.00
Fat,	6.09	3.85	3.75
Caseine,	3.95	3.31	3.50
Sugar,	5.12	5.10	5.00
Ash,	.74	.74	.75
	15.90	13.00	13.00

Richness of milk from four breeds of cows and four individual cows of each breed, at the New Hampshire Experiment Station:

NO. OF COW.	JERSEY. PER CT. FAT.	AYRSHIRE. PER CT. FAT.	HOLSTEIN. PER CT. FAT.	SHORTHORN. PER CT. FAT.
1.	5.02	3.81	3.29	4.13
2.	5.08	4.55	3.54	3.50
3.	4.34	4.28	2.85	4.15
4.	6.06	4.48	2.84	3.68
Averages,	5.12	4.28	3.13	3.86

Here we see the greatest variation is in breeds. The difference in averages' amounts to 63 per cent.; that is, the amount of fat in the Jersey milk is 63 per cent. greater than in the Holstein. The variation between the richest and poorest milk of individual cows in each breed, was as follows: Jersey, 39 per cent.; Ayrshire, 19 per cent.; Holstein, 24 per cent.; Shorthorns, 18 per cent.

What has already been said does not seem to bear much upon the subject, perhaps, but if we are to show how the richness of milk may or may not be changed, we must know what variations are due to breed and what to individuals; that is, we must fully appreciate the fact that there are wide variations due to these two causes, and we must not conclude, as some are prone to do, that because a herd of *Jerseys*, fed on one kind of food, produce milk which will make a pound of butter from sixteen pounds of milk, and another herd, of *Holsteins*, fed on a radically different food, produce milk of which twenty-five pounds are required for a pound of butter, therefore the *food* of the Jerseys produced richer milk; it is not the *food* but the *breed*. Our four breeds have been fed practically alike, and the average differences in the fat percentage in their milk is due to the *breed* and not to the *feed*.

Digitized by Google

Again, we often hear it said: "I have a Jersey cow; she is fed on hay and corn meal. She produces milk of which fifteen pounds will make a pound of butter; my neighbor has a Jersey, but he feeds her ensilage and shorts, and it takes twenty pounds of her milk to make a pound of butter; therefore I believe ensilage makes poor milk." It is needless for me to point out that such an argument is worthless. An inspection of the above table shows us that one of our Jerseys would make a pound of butter from fifteen pounds of milk, while another's milk only gives a pound of butter for twenty-one pounds of milk, and this on the same kind of food. Let me repeat, and emphasize the fact, that *breed* and *individual characteristics* are the two great factors that determine the richness of milk.

PERIOD OF LACTATION.

Another factor which has appreciable influence is the time since calving. The same cow, on the same kind of food, will yield richer milk after ten months of milking than at the end of one month.

A cow that gave milk containing 3.5 per cent. of fat in November and December, 1888, on the same kind of food in May, 1889, gave milk with 3.9 per cent, in August, on pasture feed, 4.16 per cent., and in September 4.23 per cent.

Another cow averaged 3.6 per cent. in December and November, 1888, 3.9 per cent in April, 1889, 4.4 per cent. in May. These are only two instances, but it is a fact well known that most cows do so increase. Now, this being true, we must not too hastily conclude that a given kind of food has caused increased fat in the milk, since it may be that a part or the whole of the observed change is due to a *natural* increase due to length of time in milk and not to food at all.

MORNING'S AND NIGHT'S MILK.

That there is a variation in the richness of the morning's and night's milk of most cows is generally understood, but there are some facts which are brought out by our work that are new, so far as I know, though others may have observed the same thing.

The *morning's* milk, in the case of three cows whose milk has been analyzed night and morning daily for a full year, has been richer than the *night's* milk during the time that the cows were on pasture feed, but when the same cows were put into the barn the reverse was true; that is, the night's milk was the richer. The difference between morning and night's milk is quite marked; thus, during June, July and August a Jersey cow gave milk which averaged as follows:

Morning's milk,	6.26 per cent.,	Average, 6.01 per cent.
Night's milk,	5.75 per cent.,	
Difference,	0.51 per cent., in favor of morning's milk.	

Digitized by Google

The same cow during January, February and March, gave:

Morning's milk, 5.81 per cent.,
Night's milk, 6.30 per cent., } Average, 6.05 per cent.

Difference, 0.49 per cent. in favor of night's milk.

Other cows give corresponding results, not so marked, perhaps, but nevertheless, we may fairly conclude that either the exercise involved in grazing over a comparatively large pasture, or the heat of the day, or both together, tend to diminish the richness of the milk secreted during the day, while the quiet or coolness of the night tends towards a richer product. In winter, however, our cows remain quiet both day and night, not absolutely, of course, but still the exercise during the day is very little as compared with summer; but why the night's milk should so much exceed the morning's is unaccountable unless it may be that the slightly shorter period between milking might in part explain the fact.

I have alluded to this variation because it is one of the *larger variations* which may be brought about in milk, and, certainly, so far as the difference in fat contents of the milk, night and morning, is concerned, it is not due to food, for the same food is concerned in the production of the night's milk and the morning's milk, and the difference of one-half of one per cent. must be due in summer, at least, to other causes than *food* or time of milking, for the periods between milking are equal at that season of the year.

FREQUENCY OF MILKING.

An experiment was conducted with two cows, for the purpose of noting the effect of very frequent milking. A Shorthorn cow was milked every hour, for twenty-four hours, and a sample of each milking was analyzed. At the time of the commencement of the experiment this cow was giving 14.25 pounds of milk daily, in which there was 3.89 per cent. of fat, or .554 pounds of actual fat daily. In twenty-four hours, of hourly milking, she produced 16.25 pounds of milk, in which was 5.27 per cent. of fat, or of total fat, .856 pounds, an increase of fifty-four and one-half per cent in the total fat, in twenty-four hours.

The other cow, a Jersey, produced, previous to the experiment, 10.07 pounds, in which was 6.02 per cent of fat, or .606 pounds. The test was for seventy-two hours, and I will divide it into three daily periods:

	AMOUNT OF MILK.	PER CENT. OF FAT.	ABSOLUTE FAT PER DAY.	GAIN. PER CENT.
1st day,	10.5	7.05	.743	27¼
2nd "	10.6	5.94	.630	4
3rd "	10.9	5.74	.626	3⅓
Total,	32.0	18.75	19.99	
Average,	10.6 pounds.	6.24	.666 pounds.	10

Digitized by Google

When cows go from barn feed to pasture grass in May, they are changed onto very watery food, and it is generally thought that while there is usually a considerable increase in quantity, there is also a decrease in solids in the milk.

During the year from Sept., 1888 to Sept., 1889, the milk of three cows, two Shorthorns and a Jersey, was analyzed daily, night and morning. One of these dried off at about the time of going to pasture, and so I can not give any figures of value on this point from her milk; the other two however were affected as follows:

EFFECT OF PASTURE GRASS ON QUANTITY AND QUALITY OF MILK.

	JERSEY.	SHORTHORN.
Increased Milk,	2.3 pounds daily.	2 pounds daily.
" Fat,	.2 of one per cent.	.05 of one per cent.
" Caseine,	(no change.)	.15 " "
" Solids,	.2 of one per cent.	(no change.)
Decreased Sugar,	(no change.)	.2 of one per cent.

Here we have two ways by which the quality of milk was affected. The Shorthorn's milk was not appreciably enriched, it is true, but, so far as it was affected, there was no change in the per cent. of water and solids, but the fat and caseine together were increased .2 of one per cent., while the sugar was decreased exactly the same amount.

The Jersey milk was not changed in sugar or caseine, but the fat was increased, and to the same extent the per cent. of solids was made more.

On the whole herd numbering about twenty, the milk was increased, while the amount necessary to produce a pound of butter was decreased about 1.5 pounds.

Here we see that succulent food made more milk and better milk.

ENSILAGE.

The substitution of ensilage for dry fodder has, by some writers been characterized as a "polite way to water milk;" is this true?

Two Shorthorn cows gave the following results, when changed from dry fodder to ensilage:

	No. 1.	No. 2.
Increased Milk,	½ lb. daily.	½ lb. daily.
" Solids,	.3 of 1 per cent.	(no change.)
Decreased Sugar,	(no change.)	.17 of 1 per ct. daily.
" Solids,		.07 " " " "
Increased Fat,	.15 of 1 per cent. daily,	.01 " " " "
" Caseine,	.08 " " " "	.20 " " " "

Digitized by Google

There is no evidence here that ensilage waters the milk; in fact, the only thing really proven is that the variation is very small; but, so far as there is any change, the tendency is for ensilage to make more milk and better milk than dry fodder, thus corresponding with pasture feed. In table 1, following, it will be seen that Lot G on ensilage gave more milk, and milk that was richer in all solids, except caseine.

CHANGING THE NUTRITIVE RATIO.

A change of "nutritive ratio" means feeding rations in which the proportion of albuminoids to non-albuminoids is changed. For example, two rations, made up as follows, have been fed:

	RATION, 1 a.	RATION, 7 a.
Ensilage,	44 lbs,	44 lbs.
Hay,	5½ "	5½ "
Corn Meal,		6 "
Middlings,	3 "	3 "
Gluten,	6 "	
Nutritive Ratio,	1 : 5.2	1 : 9

This may be regarded as a wide variation; the ration 1a is a little richer in albuminoids than the German standard requires, but the 7a combination is an excessive starchy ration. If the character of the food exerts any marked effect on the *quality* of the milk it would seem that these two rations ought to make themselves felt.

At the same time that these two rations were being fed, other rations, intermediate between them, were also fed. Each lot of cows consisted of two, and the lots were alternated, being fed two weeks in each period. The following table shows the results in quantity:

		FIRST PART.		SECOND PART.	
LOT.	NUTRITIVE RATIO OF FOOD.	MILK PRODUCED IN 14 DAYS.	NUTRITIVE RATIO OF FOOD.	MILK PRODUCED IN 14 DAYS.	LOSS DUE TO WIDENING THE RATIO.
1 A.	1 :5.2	660 lbs.	1 :9	598 lbs.	62
1 B.	1 :5.2	552	1 :9	497	55
		1212		1095	117
2 C.	1 :5.6	560	1 :8	530	30
2 D.	1 :5.6	700	1 :8	635	65
		1260		1165	95
3 G.	Ensilage,	587	Hay,	512	75

The decrease in milk amounts to about 10 per cent. in the first combination, 8 per cent. in the second, and 13 per cent. in the third. Now, how much was the chemical composition varied?

Digitized by Google

	LOT. A. Jersey and Shorthorn.			LOT. B. Jersey and Ayrshire.			LOT. C. Shorthorn and Ayrshire.			LOT. D. Ayrshire and Holstein.			LOT. G.		
	Average Comp. of Milk.			Average Comp. of Milk.			Average Comp. of Milk.			Average Comp. of Milk.			Average Comp. of Milk.		
	With a Nutritive Ratio of 1:5.2.	With a Nutritive Ratio of 1:9.	Gain or Loss.	With Nutritive Ratio 1:5.2.	With Nutritive Ratio 1:9.	Gain or Loss.	With Nutritive Ratio 1:5.6.	With Nutritive Ratio 1:8.	Gain or Loss.	With Nutritive Ratio 1:5.6.	With Nutritive Ratio 1:8.	Gain or Loss.	With Ensilage 1:7.2.	With Hay 1:7.2.	Gain or Loss.
Water.	87.09	87.02		86.15	86.12		87.07	86.89		87.92	87.58		87.26	87.39	
Solids.	12.91	12.98	*.07	13.85	13.88	*.03	12.93	13.11	*.18	12.08	12.42	*.34	12.74	12.61	†.13
Fat.	3.92	3.86	†.06	4.89	4.36	†.53	3.82	4.11	*.29	3.63	3.57	†.06	3.67	3.66	†.01
Caseine.	3.19	3.35	*.16	3.48	3.64	*.16	3.38	3.31	†.09	3.14	3.16	*.02	3.22	3.29	*.07
Sugar.	5.04	5.02	†.02	4.75	5.15	*.40	4.98	4.95	†.03	4 54	4.95	*.41	5.05	4.90	†.15
Ash.	.76	.75	†.01	.73	.73		.75	.74	†.01	.77	.74	†.03	.80	.76	†.04
Solids not fat.	8.99	9.12	*.13	8.96	9.52	*.56	9.11	9.00	†.11	8.45	8.85	*.40	9.07	8.95	†.12
Ratio of cascine to fat.	1:1.23	1:1.15		1:1.40	1:1.20		1:1.13	1:1.24		1:1.15	1:1.13		1:1.14	1:1.11	
Average daily milk yield.	47.1	42.7	†4.4	39.5	35.3	†4.2	40.1	38.1	†2.0	49.9	45.4	†4.5	42.0	36.8	†5.2
Amount of butter which this milk would make.	2 03	1.81	†.22	2.13	1.69	†.44	1.68	1.72	*.04	1.98	1.78	†.20	1.74	1.48	†.26

* Gain. † Loss.

Table one, when averaged for the first four lots, gives us the decrease or increase of each constituent of the milk, due to substituting corn meal for gluten meal, pound for pound; that is,

CHANGING FROM A NARROW TO A WIDE NUTRITIVE RATIO.

DECIMAL OF A PER CENT.

	Decrease.	Increase.
Solids		.155
Fat	.09	
Caseine		.06
Sugar		.19
Ash	.01	
Solids not fat		.245

This table means, that the solids were increased $\frac{155}{1000}$ of one per cent., the fat decreased $\frac{9}{100}$ of one per cent., etc. The quantity of milk was decreased 8.5 per cent., and the quality of butter 10.5 per cent., by the change.

The amount of milk produced by each cow daily, on an average, was:

	Lbs.
On gluten, (narrow ratio)	22.07
On corn meal, (wide ratio)	20.2
Loss, (due to wide ratio)	1.87

The amount of butter was:

	Lbs.
On gluten, (narrow ratio)	.977
On corn meal, (wide ratio)	.875
Loss, (due to wide ratio)	.102

It is no part of the plan of this *Bulletin* to discuss the matter of cost of foods, or cost of milk and butter, but for the benefit of any who may wish to know, I will say that the average cost of the corn meal rations was $0.161, of the gluten meal $0.171, per day. And with the eight cows under consideration the cost of milk per cwt., with the gluten, was $0.774; with the corn meal, $0.797—a difference of $0.023 per cent. in favor of gluten.

Digitized by Google

THE RATIO OF CASEINE TO FAT.

There has been some very interesting work done by Professors Sanborn, Henry and Roberts, which seems to show that a highly nitrogenous diet, that is, one with a narrow "nutritive ratio," increases the proportion of albuminoids to fat in the dressed pig and sheep; and their conclusions are that the fat may be relatively and materially increased by starchy food, while the lean may be made relatively more plentiful by the nitrogenous food. Now, as milk is the product of growth in cows, we might reasonably expect to find a similar effect when we feed widely differing rations.

EFFECT OF NARROW AND WIDE NUTRITIVE RATIO ON RATIO OF CASEINE TO FAT.

A Shorthorn cow, whose milk was analyzed twice daily, was fed on rations varying from a nutritive ratio of 1 :5.5 to 1 :12.9. The periods were of fourteen days each, but were repeated. In the following table a number of periods are averaged together and the results stated:

No. of periods averaged.	Nutritive ratio.	Ratio of caseine to fat.
4	1 :5.7	1 :1.180
4	1 :7.5	1 :1.175
5	1 :12.3	1 :1.098
3	*1 :5.	1 :1.14
	ANOTHER SHORTHORN COW.	
2	1 :5.8	1 :1.135
3	1 :5.2	1 :1.12
1	1 :5.1	1 :1.16
1	1 :5.1	1 :1.24

*Cow at pasture—nutritive value estimated.

A JERSEY COW.

No. of periods averaged.	Nutritive ratio..	Ratio of caseinf to fat.
3	1 :7.3	1 :1.48
3	1 :6.6	1 :1.52

From table one the following results are taken:

1 :5.4	1 :1.23
1 :8.5	1 :1.18

Digitized by Google

Thus we see that, without exception, the *starchy* food gives a larger proportion of caseine to fat than the nitrogenous diet, and we must conclude, so far as this work is concerned, that a highly nitrogenous food does not produce a highly nitrogenous milk.

BUTTER AND CHEESE COWS.

There is one point which needs mentioning, namely: The erroneous idea that, as the fat in milk decreases, the caseine increases.

We are told that cows which are giving milk poor in fat, and are therefore poor butter cows, are great cheese cows; and we are asked to believe that when the per cent. of fat is low the caseine is high. The following average results show the variation between Jerseys and Shorthorns:

		SOLIDS. PER CT.	FAT. PER CT.	CASEINE. PER CT.	SUGAR. PER CT.	ASH. PER CT.
Jersey,		15.75	6	4	5.5	75
Shorthorns,	1	12.25	3.75	3	4.8	70
	2	13.00	4.00	3.25	5.	75

It will be found that a high per cent. of fat and a high per cent. of caseine go together, and a milk rich in fat is not only a good milk for butter but also a good milk for cheese, while the reverse is also true.

And, now, in conclusion, let me say that these results which I have given are fairly representative of other results which we have on hand, and I feel warranted in saying that a given animal by heredity is so constituted that she will give a milk of certain average composition; by judicious or injudicious feeding the amount of milk daily may be very largely varied, but the quality of the product will be chiefly determined by the individuality of the cow. We may fertilize the soil around our grafted apple tree and cause it to produce double the amount of fruit that it would have produced uncared for, but we shall never change the Baldwin apple into a Pound Sweeting, or the Crab apple into a Pippin; the kind of apple is determined by the character of the tree, the amount by the character of the food; so of the cow. A Shorthorn cow can never, by feeding, be changed into a Jersey, and the man who starts out to increase the fat in milk by simply changing the food has, in my opinion, a very difficult task to perform. Slight variations are always cropping out, whether we change the food or not, but changes of per cent. of fat, of any considerable amount, do not appear to trace to food influence, so long as the food is reasonably well proportioned and sufficient in quantity.

Quantity is the result of food influence. Quality is the result of the make-up of the animal.

G. H. WHITCHER, *Director.*

Digitized by Google

Files

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION,

HANOVER N. H.,

BULLETIN NO. 10.

CO-OPERATIVE

FERTILIZER EXPERIMENTS.

COMPARISON OF MANURE, PREPARED FERTILIZER, ASHES, AND CHEMICALS.

MARCH, 1890.

Digitized by Google

FEB 21 1929
LIBRARY

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

BOARD OF CONTROL:

Hon. Warren Brown, President,	Hampton Falls.
Rev. S. C. Bartlett. LL.D.,	Hanover.
Hon. S. B. Whittemore,	Colebrook.
Hon. G. A. Wason,	Nashua.
Prof. G. H. Whitcher, Secretary,	Hanover.

OFFICERS:

G. H. Whitcher,	Director.
A. H. Wood,	Supt. Dairy Dept.
H. H. Lamson,	Microscopist and Photographer.
F. W. Morse,	Chemist.
C. L. Parsons,	Asst. Chemist.
C. H. Petter,	Meteorologist.
J. M. Fuller,	Station Farmer.
C. W. Whitcher,	Clerk.

Digitized by Google

CO-OPERATIVE FERTILIZER EXPERIMENTS.

It is commonly believed that experiments with fertilizers are of little use, except in the immediate locality in which they are made; some even advocating the idea that no two parts of the same farm have the same needs, and that the use of fertilizing materials is, and must be, from the nature of the case, a hap-hazzard undertaking, upon which study and investigation can throw little if any light.

I do not believe, however, that the case is as hopelessly involved in darkness as this view would lead us to conclude, and I am convinced that the feeding of plants will in time be placed on footing more nearly approaching that on which the feeding of animals now stands. It is not the purpose of this Bulletin to discuss this part of the subject but rather to present the results of a series of coöperative experiments carried on by direction of the Station on farms in various parts of the State.

OBJECT OF THE EXPERIMENTS.

The object was to determine, by field tests, the relative proportion of *Nitrogen*, *Phosphoric acid* and *Potash* which should form the most perfect *crop ration* for the soils and crops experimented on, and in connection with this, as a means of comparison, four plots in each set were left with no fertilizer of any kind, to determine the natural capacity of the soil; one plot had one of the best commercial fertilizers found in our market, one plot had ashes and concerning one plot, No. 6, no suggestion was made, the intention being for each farmer to use whatever he might have, either in the way of manures or commercial goods on this.

COST OF FERTILIZER.

In each case, except plot 8 where manure was used, the fertilizer or chemicals cost 50 cents per plot or $10.00 per acre; the manured plot had 30 bushels of farm yard manure, which is at the rate of about 7 cords per acre, the value of

Digitized by Google

which, on an average, may be placed at $20.00 (that is about twice the cost of the fertilizer, chemicals and ashes.) This amount of manure was used because it was believed to be about what our farmers would call a full average application for corn.

PARTIES WHO UNDERTOOK THE WORK.

The thanks of the Station and of the farmers of the State are due the following gentlemen who assisted in this undertaking: Hon. D. H. Goodell, Governor of the State, Antrim, N. H.; Hon. Warren Brown, Pres't Board of Control, Hampton Falls, N. H.; Hon. S. B. Whittemore, Member of Board of Control and of Board of Agriculture, Colebrook, N. H.; Alonzo Towle, M. D., Member Board of Agriculture, Freedom, N. H.; Charles McDaniel, Esq., Master State Grange, West Springfield, N. H.; F. T. Stanton, B. S., Strafford Corner, N. H.; C. C. Beaman, Esq., Cornish, N. H.; James Wood, Esq., Lebanon, N. H.; J. L. Gerrish, Esq., Mast Yard, N. H.; J. E. Whitcher, Esq., Strafford, N. H.

The last mentioned experiment was a continuation of a series commenced in 1888, and ruined by the early frost of that year, it cannot be compared with the other results since the plan was materially modified the past year.

PLAN OF FIELD.

The outside dimensions of the plowed field were to be 185 feet by 281 feet, this enabled one to lay off 20 plots each 33 feet by 66 feet, leaving an outside blank space four (4) feet wide all around the field and a space three (3) feet wide between each plot. Each plot was to have ten (10) rows with twenty (20) hills in each row or at the rate of 4000 hills per acre.

Table 1 is so arranged that the number of the plot is shown across the top, the kind of fertilizer used is shown in the left hand column; the number of pounds of any given substance used on a given plot will be found by looking opposite that substance, in the column marked at the top with the number of the plot, for example, if it is desired to know what the fertilizer on plot 13 was, we look in the column headed 13, following down this we come to 16½ pounds and looking at the left of this we see that this was dissolved bone black; 5 pounds of muriate of potash and 3½ pounds of sulphate of ammonia, make up the total application on that plot.

Digitized by Google

The lower three lines of figures in the table show the chemical composition of the material used on the various plots,

TABLE 1. FERTILIZERS USED IN CO-OPERATIVE EXPERIMENTS.

Kind and Amount of Fertilizer.	No. of Plot.																			
	1	3	4	5	8	9	10	12	13	14	15	16	18	19	20					
Dissolved bone-black,	lbs.	lbs.	lbs.	lbs	bu.	lbs.	lbs.	bu.	lbs	lbs.	lbs.	lbs	lbs.	lbs.	lbs					
Muriate of potash.	18½	24¼	14	17¼		17½	16½		16½		18½	10½			33⅓					
Sulphate of ammonia.	3⅔			2¾		8¾	5		5		3⅔	9½		22¼						
Ashes,	3⅔	6	7¼		20	1	3½	2	3¼	28	3⅔	3¼	12½							
Manure,																				
Prepared fertilizer,																				
Analysis of Fertilizer.																				
Phosphoric acid,	11.4	12	8	10.5	0.23	10.5	10.5	1.5	10.5	12.4	11.4	7.2			16					
Potash.	7	10		43.5	0.48	16	10	6.5	10	2	7	20.4		50						
Nitrogen.	2.8		6.8	2.8	0.48	0.7	2	8		2.8	2.5	2.8	2.8	20						

thus No. 13 had a mixture which by analysis showed 10.5% of phosphoric acid, 10% of potash and 2.8% of nitrogen.

Digitized by Google

Table 2. Yields of Husked Corn and Fodder per Acre.

		Stanton.	Goodell.	Baker.	Gerrish.	Wood.	Brown.	Beaman.	Average. Corn.	Average. Fodder.
1	C	52½	44½	**77.1**	**93**	68¼	32½	85	69.94	
	F	5200	1760		2685	2853	2800	5200		*3408*
2	C	37½	7½	13.6	69.7	18.1	65½	71	40.41	
	F	4200	520		1735	1220	3280	3000		2326
3	C	55	**93**	47½	**93**	**92.5**	*70*	63½	*73.50*	
	F	3600	2180		2635	4216	2900	4500		*3338*
4	C	**87.5**	45	20¼	**89.3**	16.4	66	76½	57.27	
	F	4000	1380		2480	1111	3160	3120		2542
5	C	**103.8**	33	30½	69.7	78.4	52½	50½	59.76	
	F	6500	1640		2170	4932	2700	4560		**3740**
6	C	65	**97.5**	**72.8**	67¾	*83.5*	*69 5*	62	*74.00*	
	F	3000	3080		1555	3600	3220	3000		2909
7	C	47½	40	9¾	35.8	18.4	*68.5*	54	39.13	
	F	3000	1480		1085	1584	3260	2860		2211
8	C	62½	**74**	**89.8**	**108.5**	**113.1**	67½	**112.5**	**89.69**	
	F	5000	2020		3150	5704	2500	4000		*3739*
9	C	72½	*54*	*67*	79.4	**161.8**	63	**106**	**77.66**	
	F	5200	1980		2625	4127	3080	4800		**3787**
10	C	61 3	34	*72.6*	77.5	*86.3*	35	*103*	*67.08*	
	F	5000	1640		1860	3000	2300	5100		3250
11	C	50	20	11.6	42.6	10½	60	84½	41.17	
	F	4000	940		1085	2016	1800	3900		2290
12	C	*80*	38½	45.4	62	80½	56	*95.5*	65.71	
	F	3200	1400		1705	2803	2560	4900		2595
13	C	**115**	*68*	*68.1*	73.6	*82.8*	23	94½	**75.60**	
	F	5200	2000		2325	4280	4480	4800		**3847**
14	C	70	36	58¼	60¾	55.6	67½	88	63.58	
	F	4500	1440		2015	2534	3700	3000		2865
15	C	40	39	66¾	*83.3*	78.8	48	72	61.11	
	F	2400	1800		2825	3564	2880	4200		2861
16	C	30	41	54½	*89.1*	72.4	**82 5**	48½	59.70	
	F	2500	1860		2790	4268	3300	3000		3108
17	C	17½	27		54¼	20¼	**77**	60	48.06	

Digitized by Google

CONDITIONS UNDER WHICH WORK WAS DONE.

ie Station put up the fertilizers except for plots 8, 6, and farmer was to furnish use of land, was to lay out the nd plant according to directions, record certain observed n blanks furnished and to harvest and report weights. is, no compensation, other than the fertilizer was given.

RESULTS OBTAINED.

hile the results cannot be regarded as perfect, in fact fall ort of that, nevertheless it is believed that they are valua- even of the ten farmers worked on corn which was husk- ne of these by reason of sickness did not report on of fodder) one planted corn for ensilage, one sweet or a canning factory, and one experimented on potatoes. able 2 gives the yield per acre of husked corn, 40 lbs. per as husked, and of fodder, for each plot on each of the sets; plots 17, 18, 19 and 20, on Mr. Baker's acre, were ed by crows; the last two columns in the table give erage yield of corn and fodder from each plot, for the tests. In this table the THREE BEST YIELDS ARE PRINTED CK-FACED TYPE, *the next three best in italics.*

aking this table as it stands and the best yield of corn is o be from manure, followed by plots 9 and 13, while the amount of fodder is found on plot 13, followed by 9 and

we select and average the three best plots, not including e with manure, in each set, we can then compare the re- rom chemicals with those from manure, prepared fertil- nd ashes, and by averaging the four plots with no fertili- have the data for determining the relative efficiency of nethod of supplying plant food. This method of condens- sults has been applied to table 2 and as a result we get 3, the upper half being for *huskea corn* the lower for *fodder.* able 3 shows us that the average yield of husked corn nanure was 89.69 bushels, from the best three combina- of chemicals 90.62 bushels, from prepared fertilizer 63.58 ls, from ashes 65.40 bushels, and from plots not fertilized oushels.

o the farmer these figures mean a great deal, provided ney are representative results; now as the cost of chemi-

Digitized by Google

cals, ashes, and prepared fertilizer are the same, any gain in product of one over the other represents profit, and we may

TABLE 3. COMPARISON OF MANURE, PREPARED FERTILIZERS AND CHEMICALS.

	Stanton.	Goodell.	Baker.	Gerrish.	Wood.	Brown.	Beaman.	Average.
	bu	bu.	bu.	bu.	bu.	bu.	bu.	bu.
Manure,	62.5	74	89.75	108.5	113.1	67.5	112.5	**89.69**
	115	97.5	77.1	93	101.75	82.5	110.5	
Best three plots,	103 75	93	72.75	93	92.50	81	106	
	87.50	68	72.6	89 25	86.25	77	103	
	306 25	258.5	222.45	275.25	280.50	240.5	319.5	
Average.	*102 08*	*86.2*	*74.15*	*91.75*	*93.5*	*80.2*	*106.5*	**90.62**
Prepared fertilizer,	70	36	58.25	69.75	55.6	67.8	88	**63.58**
Ashes,	80	38.5	45.4	62	80.5	56	95.5	**65.4**
No fertilizer,	38.1	23.6	11.6	50.6	20.5	67.7	67.4	**41**
			FODDER.					
	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.
Manure,	5000	2020		3150	5764	2500	4000	**3739**
	6500	3080		2790	4932	4480	5200	
Best three plots,	5200	2180		2035	4238	3980	5100	
	5200	2000		2035	4280	3700	4800	
	5633	*2420*		*2686*	*4503*	*4055*	*5033*	**4046**
Average,	4500	1440		2015	2534	3700	3000	**2865**
Prepared fertilizer.	3200	1400		1705	3803	2580	2900	**2595**
Ashes.	3050	1005		1325	1676	2845	3155	**2176**
No fertilizer,								

well ask the question, Why do chemicals average a better yield than the prepared fertilizer?

Digitized by Google

The first step in answering this is to determine just what kind of plant food has been supplied in each case, and the proportion of the several kinds. If we take the fertilizers used on those plots which gave the three highest yields in each set, and average the per cent. of nitrogen, phosphoric acid and potash, we get the results given in table 4.

TABLE 4. COMPOSITION OF BEST CHEMICALS USED.

		Stanton.	Goodell.	Baker.	Gerrish.	Wood.	Brown.	Beaman.	Average.
On Corn.	Phosphoric acid, %,	7	11.5	11.2	11.6	11.3	3.6	7.0	**9**
	Potash, %,	17.8	7.6	6.3	5.6	10	10.2	8.7	**10.7**
	Nitrogen, %,	4.1	1.8	2.7	3.2	1.9	11.4	7.8	**4.7**
On Fodder.	Phosphoric acid, %,	7.3	11.5		10.5	5.9	11.1	10.8	**9.5**
	Potash, %,	8.6	7.6		12.5	24.6	9.3	9.0	**11.9**
	Nitrogen, %,	2.8	1.8		1.9	2.8	2.0	2.8	**2.3**

The upper half of this table shows what kind of a fertilizer proved best for the production of corn on each of the seven farms, the last column averages all of these. The lower half of the table shows the same thing for the production of fodder, consequently these results may be regarded as applicable where the design is to raise ensilage; combining these averages and we may fairly claim, so far as the teachings of these experiments are concerned, that the best results come from a fertilizer, with the following chemical composition: (beside it is given the average analysis of 18 fertilizers sold in N. H. in 1889)

	Chemicals producing best results.	Average of fertilizers sold in N. H. in 1889.
Phosphoric acid	9.25	11.08
Potash	11.3	2.57
Nitrogen	3.5	2.45

The difference is very easily seen and we are forced to conclude that our prepared fertilizers are deficient in potash.

Or if we select from table 2 those three plots which yield highest in the average of *all* of the sets namely, 9, 13 and *6 the average composition is as below.

	Husked Corn.	Fodder.	Average of the two.
Phosphoric acid	10.7	7.	8.8
Potash	9.5	23.1	16.3
Nitrogen	2.	2.1	2.0

The best plots on fodder were 13, 9, 5.

*6 received a variety of fertilizers among the different experimenters.

Digitized by Google

These results are in no wise unusual; in our five years' work on the Station Farm, some of the results of which were reported in Bulletin No. 6, it has been found that the six combinations of chemicals which have given the highest income, on corn, per dollar invested have averaged:

Phosphoric acid	6.4
Potash	15.5
Nitrogen	2.5

EXPERIMENTS WITH ENSILAGE, SWEET CORN AND POTATOES.

The following are the results of experiments with the same combinations as for corn, on the crops above mentioned.

TABLE 5.

	Towle. Sweet Corn. value per acre.	Whittemore. Potatoes. bu. per acre.	McDaniel. Ensilage. lbs. per acre.
1	**$68 60**	**172**	9120
2	28.40	110	6480
3	57.40	**180**	11160
4	19.60	110	*5460
5	*30.80	115	7680
6	*41.8	**160**	*12320*
7	35.40	80	7720
8	*40.40	*148*	*11520*
9	**57.80**	*150*	**13760**
10	*57.60*	*143.5*	11000
11	31 60	70	6200
12	*55 40*	71.5	**12400**
13	*50 20*	104	*11920*
14	**60.20**	128.5	10320
15	*41.20	127.5	11200
16	*42.60	90	10120
17	28.80	110	7000
18	32.60	16.3	7600
19	28.60	28	**12800**
20	48 20	98.5	9900

*A different variety of corn.

	Towle. Sweet Corn Value of crop *	Whittemore. Potatoes bu.	McDaniel. Ensilage lbs.
Manure,		148	11520
Average of best 3 plots of Chemicals,	$61.33	171	12986
Prepared fertilizer,	$60.20	128½	10320
Ashes,	$55.40	71½	12400
No fertilizer,	$31.05	87	6850

*An accidental changing of seed puts this plot in another series.

Digitized by Google

The superiority of chemicals over prepared goods is again monstrated in these trials. The composition of the fertilizers ng best three yields is as follows:

	Towle.	Whittemore.	McDaniel.
osphoric acid %	10.8	11.0	4.0
ash %	11.0	7.1	24.1
rogen %	2.1	2.3	0.2

PLOT 6.

This plot, as before mentioned, had such fertilizers as each erimenter chose to apply.

Gov. Goodell applied 32½ pounds of Soluble Pacific ano; unfortunately this was applied *in the hill* while all er fertilizers were broadcasted, comparison under this con- on is impossible.

Mr. McDaniel used 4 bushels of hen manure on this plot; Gerrish 2 bushels of hen manure; Dr. Towle applied 28 lbs. Quinnipiac fertilizer; Mr. Baker used 28 lbs. of Bradley's ; Mr. Wood use 21½ pounds of ground bone and ½ bushel ashes, Mr. Whittemore applied 28 pounds of Stockbridge ato Manure.

COMPARISON OF COST AND PRODUCT.

Husked Corn.	Bush.	Gain over no fertilizer Bush.
erage yield with no fertilizer	41.00	
erage yield with Manure	89.89	48.89
erage yield with 3 Best Chemicals was	90.62	49.62
erage yield with Ashes	65.4	24.4
erage yield with Prepared fertilizers	63.58	22.58
Fodder.	lbs.	lbs.
erage of "nothing" plots	2170	
erage of Manured plots	3739	1563
erage of plots with Chemicals	4040	1870
erage of plot with Ashes	2595	419
erage of plot with Prepared fertilizer	2805	689

If we call the corn worth 25 cents per husked bushel and fodder worth $5.00 per ton, we can find the value of the in- ased product, and, calling the manure worth $15.00 per acre, all other plots $10.00 per acre, which is what the fertilizers ld cost in any market, we can draw up the following ex- t of cost and income:

Digitized by Google

	Cost of plant food per acre.	Value of increased yield	Value of increase per $1 invested in plant food
Corn			
Manure	$15.00	$16.00	$1.07
Chemicals	10.00	17.08	1.71
Ashes	10.00	7.15	.71½
Prepared fertilizer	10.00	7.37	.74
Sweet Corn			
Chemicals	10.00	30.28	3.03
Ashes	10.00	24.35	2.43½
Prepared fertilizer	10.00	29.15	2.91½
Potatoes			
Manure	15.00	30.50	2.03
Chemicals	10.00	42.00	4.20
Ashes	10.00	Loss	——
Prepared fertilizer	10.00	20.75	2.07½

CONCLUSIONS.

1st. Chemicals when properly mixed can fully take the place of farm yard manure as a source of plant food. this is shown by the averages of the best plots in each set (see table 3)

2nd. Chemicals when properly mixed can and do give greater increase of crop than Commercial fertilizers (see table 3 and page 7.

4th. The average chemical composition of fertilizers for New Hampshire should be *Phosphoric acid*, 9 *to* 11 *per cent.*, *Potash*, 9 *to* 15 *per cent.*, *Nitrogen* 2 *to* 4 *per cent.*, whereas the fertilizers offered to us in the market average *Phosphoric acid*, 11%. *Potash*. 2.5%, *Nitrogen*, 2.5%

To get such a fertilizer as the soil and plant demand farmers must buy crude chemicals and mix them in proportions which prove best by trial, until such time as the fertilizer manufacturers discard the present stereotyped 12—3—3 formula which does not and never did rest upon any basis either of theory or practice.

With increased confidence in their value and adaptation to New Hampshire conditions, I reprint a few of the combinations given in Bulletin No 6. The amounts are for one acre where no manure is used, and in all cases, with hoed crops, two-thirds of the mixture is to be sown broadcast and harrowed in, the remaining third to be put in the hill or drill.

Digitized by Google

I.

FOR CORN AND WHEAT.

Dissolved Bone black	325 lbs.
Muriate of Potash	100 lbs.
Sulphate of Ammonia	75 lbs.
	500

V.

OATS.

Dissolved Bone black	330
Muriate of Potash	105
Sulphate of Ammonia	65
	500

VII.

HAY.

Dissolved Bone black	225
Muriate of Potash	254
Sulphate of Ammonia	21
	500

IX.

POTATOES.

	(a)	or	(b)
Dissolved Bone black	340		300
Muriate of Potash	160		150
Sulphate of Ammonia			50
	500		500

It is hoped that this Bulletin will lead some of our farmers to test these combinations, using them side by side with Prepared fertilizers.

G. H. WHITCHER, *Director.*

The Bulletins of this Station are free to all farmers in the State who send a request for them to the Director.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Files

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

EXPERIMENT STATION,

HANOVER N. H.,

BULLETIN NO. 11.

PIG FEEDING EXPERIMENTS.

1. RESULTS OF FEEDING SKIM-MILK AND CORN MEAL VERSUS CORN MEAL AND MIDDILNGS.
2. DIGESTION EXPERIMENTS.

NOVEMBER, 1890.

Digitized by Google

FEB 21 1929
LIBRARY

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

BOARD OF CONTROL:

Hon. Warren Brown, President,	Hampton Falls.
Rev. S. C. Bartlett. LL.D.,	Hanover.
Hon. S. B. Whittemore,	Colebrook.
Hon. G. A. Wason,	Nashua.
Prof. G. H. Whitcher, Secretary,	Hanover.

OFFICERS:

G. H. Whitcher,	Director.
A. H. Wood,	Supt. Dairy Dept.
H. H. Lamson,	Microscopist and Photographer.
F. W. Morse,	Chemist.
C. L. Parsons,	Asst. Chemist.
C. H. Pettee,	Meteorologist.
J. M. Fuller,	Station Farmer.
D. E. Stone,	General Assistant.
C. W. Whitcher,	Clerk.

The Bulletins of this Station are sent free to all farmers in the State who send a request for the same to the Director.

Digitized by Google

ERTILIZER EXPERIMENTS.

ertilizer experiments for the season of 1890 were in
tinuation of similar work, which has been reported on
d in part a new line of work, relating more especially
of manures, prepared fertilizers, chemicals and ashes
o of ensilage corn; I am convinced that there is
considerable saving in the purchase of *plant food*, as
ossibility of more economical uses of manures, and I
ope that the suggestions given, and the conclusions
n the work, will be thoroughly tested by the farmers
e, for they are of use and value only as they are put
st on various soils and under existing conditions.
ed they are of no value to those for whom the work
nd is being done.

those who have tested the merits of the combinations
ut from this College in 1885, and not materially mod-
that time, there is testimony that convinces me that
l combination recommended for corn is substantially
quired for our soils, and from Massachusetts and Ver-
eive similar testimony, but while every new test adds
bability of the correctness of my position relative to
f vastly more potash than our fertilizer manufacturers
t farmers must in the end satisfy themselves by trial
wn soil; and there is no possibility of loss resulting
rial with every probability of gain.

Digitized by Google

TABLE I.

Kind of Fertilizer.	No. of Plot.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Dissolved bone-black,		bu.	lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	bu.		lbs.	lbs.	lbs.	lbs		lbs.	lbs.	lbs.
			18½	24¼	14	....				17½	16½			16½		18½	10½		....	...	32⅓
Muriate of potash,			3⅓	6	....	17¼				8¾	5			5		3⅔	9½		....	22¼	....
Sulphate of Ammonia,			3⅓	....	7¼	2¾				1	3½			3½		3⅔	3¼		12½	....	....
Ashes,							Nothing.					2	Nothing.					Nothing.			
Manure,		35																			
Stockbridge,								26													
Bowker, Hill and Drill,															28						
Bradley, XL,									26												
Analyses.																					
Phosphoric acid,	%	.23	11.4	12 8	10.5	....	....	10.7	11.8	10.5	10.5	1.5	....	10.5	12.4	11.4	7.2	....	....	....	16
Potash,	%	.48	7.0	10.0	....	43.5	....	5.0	2.1	16.0	10.0	6.5	....	10.0	2.0	7.0	20.4	....	....	50	
Nitrogen,	%	.48	2.8	....	6.8	2.8	....	4.0	2.5	0.7	2.8	....	....	2.8	2.5	2.8	2.8	....	20	....	

Digitized by Google

TABLE II.

	No. of Plot.																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Yield in bushels per acre,	238	224	206	114	132	96	194	150	190	234	130	94	186	190	204	220	92	90	124	124
Gain over average of plots with no fertilizer, bu.,	144	130	112	20	38	....	100	56	96	140	36		92	96	110	126		—4	30	30
Value of crop, @ 50 cents per bushel, $	119	112	103	57	66	48	97	75	95	117	65	47	93	95	102	110	46	45	62	62
Value of gain over plots with no fertilizer, $	72	65	56	10	19		50	28	48	70	18		46	48	55	63			15	15
Value of gain for $1 00 invested in fertilizer, $	3.60	6.50	5 60	1.00	1.90		5.00	2 80	4.80	7.00	1.80		4.60	4.80	5.50	6.30			1.50	1.50

Digitized by Google

The co-operative work carried on in 1889 was not continued, except in a single case, as there are few who are willing to devote the necessary time and trouble to the laying out of plots, and more especially to the weighing of the harvested crop. The exception above noted was a series of tests on *potatoes*, carried on by Mr. S. B. Whittemore, of Colebrook, in the heart of the potato region of New Hampshire, and the results are of interest and value to every man who contemplates purchasing fertilizers for use on this crop.

The combinations of chemicals were the same as those sent out in 1889, and in the following table is given the kind and amount of each chemical used per plot of one-twentieth acre, and also the chemical composition of the mixed fertilizer as it would have shown by chemical analysis:

It will be seen from this table that each form of plant food is used by itself (see Plots 18, 19, 20), also in combinations of two with the third omitted (see Plots 3, 4, 5), and in addition to these the three forms are combined in varying proportions (see Plots 2, 9, 10, 13, 15, 16). Plots 2 and 15 are duplicates, as are 10 and 13.

The Station mixed and sent out all the chemicals, and also the prepared fertilizer, for Plot 14, using an amount on each plot which would, at the prices then asked, cost ten dollars per acre. The prepared fertilizers used on Plots 7 and 8 were selected by Mr. Whittemore from the local market, and whether the cost was more or less than ten dollars per acre I am unable to say; it is probable, however, that two pounds more of Bradley's XL should have been used, as its selling price is usually the same as that of Bowker's H & D. Two bushels of ashes were used on the supposition that they cost twenty-five cents per bushel, which is the average price for unleached ashes, and thirty-five bushels of manure were selected because that amount would give what our farmers consider a good dressing, namely, seven cords, or twenty loads, per acre, the cost of this, however, would be twice the cost of the fertilizer used on the other plots, and this fact must be kept in mind in comparing results. All the other plots are directly comparable, since there was equal outlay on each.

Digitized by Google

ıe lower division of Table I shows the chemical analysis form of fertilizer. In the case of the manures and ashes rage of many analyses is taken, and for the prepared fer- the average as determined by the Station from samples d by the Secretary of the Board of Agriculture.

ble II *gives the yields per acre*, the value of this yield at nts per bushel; also the gain over the average of the ots with no fertilizer; and the value of the gain due to a worth of fertilizer of each kind.

at the land on which these experiments were carried on uniform quality to start with is shown by the yield of the ith no fertilizer, these plots being scattered about over e:

No. 6, no fertilizer,	96	bushels
No. 12, "	94	"
No. 17, "	92	"
Average,	94	"

(Series 1.) SINGLE ELEMENTS OF PLANT FOOD.

ots 18, 19, 20, show what each of the forms of *deficient od* were able to produce on this soil: Nitrogen alone, in n of sulphate of ammonia, yielded ninety bushels, an act- over plots with no fertilizer; Potash alone, in the form ate, yielded one hundred and twenty-four bushels; Phos- acid alone, in the form of dissolved bone-black, yielded ndred and twenty-four bushels. A gain in each case of ushels.

far as this series is concerned, we should be justified in ling that nitrogen was of no use, and that potash and oric acid are of equal importance, but I wish to express ef that these tests with *only one form of plant food* are of le if any use, but as they are a part of almost every of soil testing I have always put in a set, more to con- the common custom than from any idea that they would nything of much importance.

2.) COMBINATIONS OF TWO ELEMENTS OF DEFICIENT PLANT FOOD.

ts 3, 4, 5 were designed to show whether either of the utritive elements could be dispensed with.

Digitized by Google

Plot 3, furnished with phosphoric acid and potash, yielded 206 bushels

Plot 4, furnished with phosphoric acid and nitrogen, yielded 114 bushels

Plot 5, furnished with potash and nitrogen, yielded 132 bushels.

So far as this series of plots is concerned we have evidence that nitrogen is of the least importance, potash of the most, and phosphoric acid intermediate, and it is clearly the case that phosphoric acid and potash combined give a good crop, well up towards the complete mixtures.

Combining the evidence from Series 1 and 2 and we get the following:

			Amount Per acre. lbs.	Yield Per acre bu.
(a)	Plot 20.	Dissolved bone black,	666	124
	Plot 4.	Dissolved bone-black,	280	114
		Sulphate of Ammonia,	145	
	Plot 3.	Dissolved bone-black,	485	206
		Muriate of potash,	125	
(b)	Plot 19.	Muriate of potash,	445	124
	Plot 5.	Muriate of potash,	345	132
		Sulphate of ammonia,	55	
	Plot 3.	Muriate of potash,	125	206
		Dissolved bone-black,	485	
(c)	Plot 18.	Sulphate of ammonia,	250	90
	Plot 4.	Sulphate of ammonia,	145	114
		Dissolved bone-black,	280	
	Plot 5.	Sulphate of ammonia,	55	132
		Muriate of potash,	345	

Group (*a*), Plot 4, shows that substituting 145 lbs. of sulphate of ammonia for 386 lbs. of the dissolved bone-black, in Plot 20, decreases the yield 10 bushels; but in Plot 3, substituting 125 lbs. of muriate of potash for 181 lbs. of the dissolved bone-black gives an increase of 82 bushels.

In group (*b*), Plot 5, the substitution of 55 lbs. of sulphate of ammonia for 100 lbs. of the muriate of potash in Plot 19, increases the yield 8 bushels; while in Plot 3, replacing 320 lbs. of the muriate of potash in Plot 19, with 485 lbs. of dissolved bone-black increases the yield 82 bushels.

Group (*c*) shows that replacing 105 lbs. of sulphate of ammonia with 280 lbs. dissolved bone-black added to the yield 24

Digitized by Google

and that when 195 lbs. of sulphate of ammonia were re-
by 345 lbs. of muriate of potash the increase was 42

e three groups show that the greatest yield comes from
ric acid and potash, (Plot 3); the next best from nitro-
potash, (Plot 5); the next from phosphoric acid alone,
), and from potash alone, (Plot 19); the next from phos-
cid and nitrogen, (Plot 4); and the poorest from nitro-
e, (Plot 18).

(Series 3.) COMPLETE CHEMICALS.

his series three elements of plant food are combined in
ways, the object being to form some idea of the "crop
best suited to the conditions of this soil for the potato
this end the method suggested in Bulletin No. 6 of this
p. 15, was practiced, and in plots 2, 9, 10, 13, 15, and
ave combinations of the three fertilizing chemicals which
same per acre, but which differ very materially in the
on of their parts as the per cent of phosphoric acid, pot-
nitrogen, given in Table 1, will show.

Plots.	Analysis.			Yield per acre.
	*P_2O_5.	K_2O.	N.	bu.
2 and 15,	11.4	7	2.8	214
10 and 13,	10.5	10	2.8	210
16,	7.2	20.4	2.8	220
9,	10.5	16	0.7	190

up (*e*) differs from (*d*) by decreasing the per cent of
ic acid and increasing the per cent of potash. So far
rage is concerned the yield was slightly decreased by the
, but it will be observed that there is a wide difference
ld of the plots 10 and 13. The cause of this is un-
o me, and while I feel sure that there was some local
nce which seriously affected plot 13, yet I have aver-
ith its duplicate. As a matter of fact, however, I have
but that the yield from group (*e*) should have been
rer that of plot 10.
Plot 16, however, where still further reduction of phos-

O_5 means phosphoric acid; K_2O means potash; N
trogen.

Digitized by Google

phoric acid was made and potash increased, the yield was somewhat increased.

Plot 9 is comparable with group (*e*), the object was to decrease the nitrogen and increase the potash; this change caused a very decided loss.

Taking these plots together we may fairly infer that 7.2 per cent of phosphoric acid is ample for the soil under consideration; that 20.4 per cent of potash is better than 7, and that 0.7 per cent of nitrogen is not enough.

There is other evidence that shows that some nitrogen is needed.

Take the following plots:

	P_2O_5.	K_2O.	N.	
9,	10.5	16	0.7	yields 190
10 and 13,	10.5	10	2.8	" 210
3,	12.8	10	0	" 206

Now, if we remember, that plots 10 and 13 should, without doubt, have averaged more than 210 bushels, we shall see that the substitution of phosphoric acid in plot 3 for *all* of the nitrogen in 10 and 13 resulted in loss, and exchanging the greater part of the nitrogen for potash (see Plot 9), also resulted in loss, we must conclude, therefore, that from one to three per cent of nitrogen is needed on soils where potatoes are the first crop in a rotation, but had corn or any crop which had received manure or a nitrogenous fertilizer preceded this potato crop it is very likely true that nitrogen would not have been needed.

(Series 4). PREPARED FERTILIZERS.

This series, made up of Plots 7, 8 and 14, were designed to test the relative merit of $10.00 worth of plant food in the best mixed goods, and $10.00 worth in chemicals.

No. 7, with 26 lbs. of Stockbridge potato fertilizer, yielded 194 bushels.

No. 8, with 26 lbs. of Bradley's XL fertilizer, yielded 150 bushels.

No. 14, with 28 lbs. of Bowker's Hill and Drill fertilizer, yielded 190 bushels.

The following represents average analyses of these fertilizers:

Digitized by Google

		P_2O_5.	K_2O.	N.
ockbridge,	%	10.7	5.0	4.0
adley XL,	%	11.8	2.1	2.5
wker H. and D.,	%	12.4	2.0	2.5

means of obtaining a comparative statement of the s, I have given below a table showing the average re- each series:

	Yield. bu.	Gain over no ertilizer, bu.
ngle element of plant food,)	113	19
wo elements of plant food,)	150	56
hree elements of plant food,)	210	116
epared fertilizer,)	178	84
shes,)	130	36
anure,)	238	144
fertilizer of any kind,	94	

e can be no doubt as to the relative efficiency of series since the amounts used would cost the same. The thir- shels increase represents an absolute gain due solely to f mixed chemicals in place of the best of prepared fer-

cause of the increased efficiency is easily discerned, ume that the prepared fertilizers above mentioned were m good grade materials, and that the plant food, shown sis, was available. The following comparison of the chemical composition of the fertilizers in each series le explanation.

		P_2O_5.	K_2O.	N.
(Complete chemicals,)	%	10.2	11.7	2.5
(Prepared fertilizer,)	%	11.6	3.0	3.0

conclusion is fully warranted that *more potash is needed* prepared fertilizers furnish.

MANURE AND CHEMICALS COMPARED.

Plot 1 manure was used, as has already been stated, at of seven cords, or $20.00 worth, per acre. That is, much in cost as of either of the fertilizers, and while is the largest of any plot, it is only four bushels ahead o, and if we compare the value of the gain per one dol-

Digitized by Google

lar of fertilizer, as in the last part of Table II, it will be seen that one dollar invested in manure gave only an increaes worth $3.60; while one dollar invested in complete chemicals gave an increase worth $5.80, and one dollar invested in the best combination (Plot 10) gave an increase worth $7.00, and one dollar invested in prepared fertilizer gave an increase worth $4.20.

Here are figures well worth careful consideration, and they do not stand alone, for in Bulletin No. 10 will be found the report of a duplicate series, made in 1889 by the same party, which shows the same general results, demonstrating the value of such tests when properly carried out.

For the purpose of showing the composition of the fertilizer producing the best results I have selected those giving the *three highest* yields as well as the one giving the *highest*, both from the experiments of 1889 and 1890, and have given below the chemical composition:

		1889.	1890.
Best 3 yields,	P_2O_5, %	11.6	9.7
	K_2O, %	7.1	12.4
	N, %	2.3	2.8
Best yield,	P_2O_5, %	12.8	10.5
	K_2O, %	10.0	10.0
	N, %		2.8

CONCLUSIONS.

The above results so fully confirm previous observations, that I shall simply reprint the conclusions given in Bulletin No. 10 of this Station, p. 12:

1st. Chemicals when properly mixed can fully take the place of farm yard manure as a source of plant food.

2nd. Chemicals when properly mixed can and do give greater increase of crop than commercial fertilizers.

4th. The average chemical composition of fertilizers for New Hampshire should be *Phosphoric Acid*, 9 *to* 11 *per cent*, *Potash*, 9 *to* 15 *per cent*, *Nitrogen*, 2 *to* 4 *per cent*, whereas, the fertilizers offered to us in the market, average *Phosphoric Acid*, 11 *per cent*, *Potash*, 2.5 *per cent*, *Nitrogen*, 2.5.

HOW TO GET CHEMICAL FERTILIZER.

Dissolved bone-black, containing sixteen per cent of available phosphoric acid, muriate of potash, containing fifty per cent

Digitized by Google

al potash and sulphate of ammonia, containing twenty
it of nitrogen, are all of the substances required for pre-
such fertilizers as will give the best results. These can
ght of any wholesale dealer in, or manufacturer of fertili-
They are perfectly harmless substances, as easily and
mixed as corn meal, shorts and middlings.

he quantities required per acre will, of course, vary, but
'able I, we may easily get the amount that was actually
er acre, on any given plot, by multiplying the quantities
n the table by twenty, for example:

ot 10 gave best yield; there was used on this at the fol-
rate per acre:

Dissolved bone-black,	330 lbs.
Muriate of potash,	100 lbs.
Sulphate of ammonia,	70 lbs.
	500 lbs.

or the third time I will reprint the combinations which
ow been tested for the past five years:

CORN.

or potatoes on land where no manure has been used for
many years.)

Dissolved bone-black,	325 lbs.
Muriate of potash,	100 lbs.
Sulphate of ammonia,	75 lbs.
	500 lbs.

POTATOES.

(Following a manured crop.)

Dissolved bone-black,	340 lbs.
Muriate of potash,	160 lbs.
	500 lbs.

would only ask the farmers of New Hampshire to try these
ations, even if at some trouble and extra expense, for I
tain that on by far the greater part of our soils, such
s will prove superior to the prepared goods as now com-
d.

G. H. WHITCHER, *Director.*

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Files

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

PERIMENT STATION,

HANOVER, N. H.,

BULLETIN NO. 13.

EFFECT OF FOOD ON BUTTER.
EFFECT OF FOOD ON QUANTITY OF MILK.

MAY, 1891.

Digitized by Google

FEB 21 1929
LIBRARY

ORGANIZATION

— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station

BOARD OF CONTROL:

HON. WARREN BROWN, President, - Hampton Falls
REV. S. C. BARTLETT. LL.D., - - - Hanover
HON. S. B. WHITTEMORE, - - - - Colebrook
HON. G. A. WASON, - - - - Nashua
PROF. G. H. WHITCHER, Secretary, - - Hanover

OFFICERS:

G. H. WHITCHER, - - - - Director
A. H. WOOD, - - - - Supt. Dairy Dept
H. H. LAMSON, - - Bacteriologist and Photographer
F. W. MORSE, - - - - Chemist
C. L. PARSONS, - - - - Asst. Chemist
C. H. PETTEE, - - - - Meteorologist
C. M. WEED, - - - - Entomologist
J. M. FULLER, - - - - Station Farmer
D. E. STONE, - - - - General Assistant
MISS M. E. FULLER, - - - - - Clerk

The Bulletins of this Station are sent free to all farmers in the State who send a request for the same to the Director.

Digitized by Google

ARDNESS OF BUTTER;

THE EFFECT OF FOOD UPON.

A. H. WOOD AND C. L. PARSONS.

now commonly admitted that the composition of milk determined by the breed and individuality of the cow, the effect of any normal food upon the percentage of fat l in the milk is very slight, hence the problem of feeding milk producer, narrowed to finding the food that will herd to yield the greatest amount of milk at the least out injury to the health of his cows. To the maker of owever, the problem is still a very broad one, for even if ontents of the milk be practically constant and he be obtain the maximum quantity of butter it may fall far he highest quality, on account of the effect of the food *composition* of the butter fat.

t the composition and characteristics of butter fat are by the food of the cow is not new, in fact, it is a matter on observation and remark; but, without doubt, in es greater changes in the quality of butter are attrib- hanges in foods than the facts justify.

study of the effect of foods upon the resulting butter portant and difficult one, and this Bulletin is intended contribution to what has been, and an indication of be learned in this direction.

in the last few years gluten meal has come into exten- as a food rich in albuminoids; and as a milk producing proved itself one of the best.

luten meal is a by-product in the manufacture of glu- n corn and contains all the substance of the original h the exception of the bulk of the starch, it might be

Digitized by Google

expected that it would have a similar effect upon the character of the butter fat when fed to cows in a normal ration.

To test the relative effect of corn meal and its by-product gluten, in this direction, the following work was carried out: Eight cows were divided into four lots of two each, and were fed alternately upon rations having corn meal or gluten meal as the leading constituent. Each ration was fed continuously for two weeks and the milk given on the two last days in each period was taken to test the effect of the food upon the churnability of the resulting cream, both in regard to time and thoroughness of churning, and also its effect upon the hardness of the butter, its melting point and its volatile acids.

The cream was obtained from all lots by the use of the De-Laval hand separator, and allowed to stand twenty-four hours before churning. The cream was apparently sweet when churned, and therefore lower temperatures were maintained than where acid cream is used. Samples of the butter-milk and butter were analysed, and the comparative hardness of the butters determined by means of the method hereafter described.

In Table A the blackfaced type indicate gluten, the common type corn meal. The various rations are indicated as 1a, 2a, 6a and 7a, and were made up as follows:

	1a lbs.	7a lbs.	2a lbs.	6a lbs.
Ensilage,	44	44	44	44
Hay,	6	6	6	6
Corn meal,	—	6	1	5
Middlings,	3	3	3	3
Gluten,	6	—	5	1
Nutritive ratio,	1 : 5.2	1 : 9	1 : 5.6	1 : 8

Reference to Table A will show that these four lots of cows were alternated upon these rations, which were constant so far as coarse fodder and one-third the grain ration were concerned, and that the substitution of gluten, either wholly or in part, for corn meal, had a marked effect upon the characteristics of the butter fat, decreasing its churnability and softening the product. We would not discourage, on this account, the feeding of gluten to cows, for it has proved itself to be of much value as a milk producing food, both at this Station (see Bulletin No. 9) and elsewhere. We can only caution against its excessive use with cows that nat-

Digitized by Google

roduce a somewhat soft quality of butter, and suggest
ed with cotton seed it may very likely be of great ad-
since it may be seriously questioned if cotton seed in
er season may not act too strongly in the opposite di-
producing a butter that is too hard.

TABLE A.

Lot.	Period.	Ration.	Nutritive Ratio.	Churning temperature. Deg. F.	Time churning. Min.	Fat in buttermilk. Per cent.	Hardness of butter. mm. of penetration.	Melting point of butter. Deg. C	Volatile Acids equal to — c c. decinormal $Ba(OH)_2$.	Water in butter. Per cent.
A.	1	1a.	1:5.2	55-58½	11	1.75	8.4	33.8	32.9	9.14
	2	7a.	1:9	56-59	15	.54	6.5	32.4	31.9	9.49
	3	1a.	1:5.2	52-56	25	1.30	11.7	33.2	29.9	9.20
	4	7a.	1:9	52-56	65	.34	6.4	24.0	26.7	9.60
B.	1	7a.	1:9	55-59	35	.33	4.5	35.5	33.0	9.18
	2	1a.	1:5.2	56-56½	20	.96	10.9	32.1	31.7	8.87
	3	7a.	1:9	52-56	80	.62	4.9	34.2	29.2	10.00
	4	1a.	1:5.2	53-56	11	1.21	7.7	36.5	25.1	10.82
C.	1	2a.	1:5.6	55-57	15	1.58	7.9	34.7	30.4	9.22
	2	6a.	1:8	55-59	20	.58	7.5	33.2	31.6	9.01
	3	2a.	1:5.6	52-56	40	1.05	7.8	88.8	31.4	9.68
	4	6a.	1:8	53-56	30	.53	6.0	33.1	30.0	11.67
D.	1	6a.	1:8	55-57	21	1.03	7.1	33.3	32.0	8.65
	2	2a.	1:5.6	56-59½	15	1.85	7.9	32.4	30.9	9.02

Table B the lots are also of two cows each, and the pe-
o weeks. The treatment of milk and cream was the
previously described, with this exception, that the cream
ed in shallow pans.

G and Lot X, in periods 1 and 2, represent a brief test
ge as compared with hay, the rations being as follows:

Digitized by Google

	4^a lbs.	$4a_1$ lbs.	$6a_1$ lbs.	$6a$ lbs.
Ensilage,	—	44	—	44
Hay,	22	6	25	6
Corn meal,	$3\frac{4}{16}$	$3\frac{4}{16}$	5	5
Middlings,	$3\frac{4}{16}$	$3\frac{4}{16}$	3	3
Gluten,	$3\frac{4}{16}$	$3\frac{4}{16}$	1	1
Nutritive ratio,	1 : 7.2	1 : 7.2	1 : 8	1 : 8

TABLE B.

Lot.	Period.	Ration.	Nutritive Ratio.	Churning temperature. Deg. F.	Time churning. Min.	Fat in buttermilk. Per cent.	Hardness of butter. mm. of penetration	Melting point of butter. Deg. C.	Volatile Acids equal to — c.c. decinormal $Ba(OH)_2$.	Iodine absorption number.	Water in butter. Per cent.
G.	1	$4a_1$	1:7.2	55–57	16	1.73	8.2	31.7	36.2	32.4	9.48
	2	$4a_1$	1:7.2	56–58	14	.96	9.7	31.5	36.4	—	9.54
	3	$4a_1$	1:7.2	52–57	32	1.40	7.6	36.1	32.2	—	8.40
X.	1	$6a_1$	1:8	60	55	.39	8	34.6	29.9	36.8	10.03
	2	$6a_1$	1:8	58	17	.91	9.5	33.1	32.3	31.7	10.42
	3	$2a_1$	1:5.6	53–58	20	—	18	35.7	28.5	37.9	10.06
	4	$2a_1$	1:5.6	48–58	88	1.15	14	34.3	27.8	31.6	10.93
Y.	1	$2a_1$	1:5.6	57	18	.57	18.3	32.6	34	36.8	10.22
	2	$2a_1$	1:5.6	56–59	115	.87	6	38.7	30	31.7	10.22
	3	$2a_1$	1:5.6	54–57	30	—	9.5	36.9	28	37.9	12.93
	4	$2a_1$	1:5.6	48–58	150	.69	5	37.4	27.6	31.6	12.93
Z.	1	$4a_1$	1:7.2	57	13	1.35	10.7	37.6	27.3	36.8	11.36
	2	$4a_2$	1:7.2	57.60	37	.33	6.5	38	31.8	29	11.48
	3	$4a_1$	1:7.2	54–57	14	—	8.5	32.6	38.9	36.4	11 13

In both lots *hay* apparently produced a harder butter than did *ensilage*. While as regards churnability Lot G favors hay and Lot X ensilage. Lot X, periods 3 and 4, is a change from

Digitized by Google

corn meal to gluten and reaffirms the verdict of Table A. Lot Y shows a test of gluten as compared with cotten seed, the black-faced type representing the cotton seed periods. The rations as fed were as follows:

	$2a$ lbs.	$2a_1$ lbs.
Ensilage,	44	44
Hay,	6	6
Corn meal,	1	1
Middlings,	3	3
Gluten,	5	—
Cotton seed	—	5
Nutritive ratio,	1 : 5.6	1 : 5.6

The effect of the substitution of cotton seed for gluten is very marked in the hardness of the resulting butter, and corroborates the reports from stations in the South as to the effect in this direction of feeding cotton seed in quite large quantities.*

Lot Z represents a single test of feeding skim-milk to cows, and, so far as the butter product is concerned, shows very favorable results. It is, undoubtedly, a good use for skim-milk when not needed for feeding younger animals. The rations were as follows:

	$4a_1$	$4a_2$
Ensilage,	36	36
Hay,	4½	4½
Corn meal,	2½	2½
Middlings,	2½	2½
Gluten,	2½	——
Skim-milk,	——	21
Nutritive ratio,	1 : 7.2	1 : 7.2

METHODS USED.

Wollny's modification of Reichert's method was used in the determination of Volatile Fatty Acids; Wiley's method for the determination of the melting point; and Hubl's for the Iodine Absorption Number. The hardness of the butters was measured at the same temperature by the depth of penetration of a weighted glass rod falling through a glass tube for a given

*See Bulletin 11, Texas, etc.

Digitized by Google

distance, the penetration being measured in millimeters. The following details are recommended:

The rod should be three mm. in diameter, twenty cm. long, and should weigh ten gms. It should be pointed, but the distance along inclined plane, from point to surface of rod, should be no greater than the diameter of the rod. It is easily made by pulling out a piece of glass tubing of the required size and pushing a small piece of cotton down the inside to the point thus made, filling with mercury until the whole weighs ten grams, and finally closing the open end. The tube through which the rod is to fall should be one meter in length, perfectly straight and of such diameter that the rod will fall perpendicularly through it without vibration and with scarcely any friction. At exactly the length of the rod from the lower end of this tube a millimeter scale should be attached with the scale reading downward. The butter prepared in the usual way should stand in a cool room several days, and then the depth of penetration should be taken at 15½° C., which is about the temperature at which dairy rooms are kept. The hardness of different butters is thus very simply compared, by bringing the tube in a perpendicular position over a plane surface of the butter at some distance from the edge of the mass; fixing the tube in this position, with the lower end lightly resting on the surface; then lower the ten gram rod into the tube as far as possible with the finger and thumb and let it fall. The penetration can then be read off on the scale. The greater the penetration the softer the butter. Except on very soft butters the differences in triplicate determinations is seldom over one millimeter. The results in the tables are averages of several determinations.

INDICATIONS.

The work in this direction is not as yet extensive enough to justify the drawing of conclusions, but our experiments thus far *indicate*

1st. That gluten meal tends to produce a much softer quality of butter than corn meal or cotton seed meal and, other things being equal, tends to lessen the churnability of the butter fat.

2nd. That with the same cows the hardness of butter depends much more upon the *character* of the food than upon the *nutritive ratio*.

Digitized by Google

That ensilage produces a somewhat softer butter than d hay, but it is also favorable to the flavor and texture utter product.

That skim-milk has a very favorable effect upon the ility and quality of the butter fat, and in a single trial tly reversed the general rule that the volatile fatty acids e as the period of lactation advances.

That cotton seed meal tends to produce an unusually ality of butter, and that cotton seed meal and gluten ght be used together with excellent results.

That contrary to general belief the melting point of at is not a good index of the commercial hardness of That while in general a soft butter melts at a lower ture than a hard butter *there is no definite relation between oint and actual hardness.*

That no relation can be traced between foods and fatty acids, except in the case of skim-milk. That usu- dness and volatile acids vary inversely, hardness gener- easing and volatile acids decreasing, as the period of lac- dvances.

That the Iodine absorption of butter from gluten ra- er than that of butters from cotton seed or corn meal and that so far as tried (see Table B) the Iodine absorp- nber follows very closely the hardness of butters.

Digitized by Google

QUANTITY OF MILK.

G. H. WHITCHER.

The work above reported on by Messrs. Wood and Parsons was carried on by them in connection with a series of experiments designed primarily to test the relative efficiency of a ration containing a large amount of albuminoids as against one containing a large amount of starch.

The materials for bringing about this variation in the rations were corn meal and gluten meal, the latter being a waste product from the manufacture of glucose from corn; it is, in fact, corn meal from which a large part of the *starch* has been removed, it is, consequently, rich in albuminoids and oil.

The following table gives a comparative statement of the average digestible matter in the two food stuffs:

	Corn Meal. per cent.	Gluten. per cent.
Albuminoids,	7.78	25.14
Non-albuminoids,	71.60	61.90
Nutritive ratio,	1 : 9.2	1 : 2.4

Now, as both are made from corn, it follows that whatever difference may be noticed, either in quantity or quality of the product resulting from feeding these grains, must be due the *relative proportion of albuminoids and non albuminoids*, and not to any specific differences in the characteristics of the foods, as might and probably would be the case if linseed or cotton seed were contrasted with corn meal.

In almost every case, with each of the eleven cows, a change from gluten to corn meal, that is, a change from a *narrow* to a *wide* nutritive ratio, resulted in a decided falling off in the product, while the reverse change resulted in an equally decided increase. In some cases this variation is obscured by the natural shrinkage which was all the time taking place. The following table shows the detailed results, each period being for fourteen (14) days:

Digitized by Google

Nutritive ratio.	1:6	1:7	1:6	1:7	1:5.2	1:9	1:5.2	1:9	1:5.6	1:8	1:8	1:5.6	1:8	1:5.6
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Snowflake, 2nd,	22.4	21.1												
Chinchilla,	21.7	20.5	21.2	15.13	15.2	18.7	14.7	13.5	18.9					
Countess Gazelle,					22.3	29.0	32.0	27.7						
Duchess,						16.6	18.8	16.5	15.6					
Pilots Lily,						17.4	20.7	20.1			20.4	21.2	17.8	
Maid of Arlis,											14.6	14.7	13.8	
Noethboeo Belle,									16.4					
Duchess of Hanover,											23.5	25.4	23.2	
Duchess, 2nd,		25.0	24.4						23.7		24.5	28.7	28.2	30.00
Clio,														
Frost,														

The following conclusions seem fully warranted, namely:—

The proportion of albuminoids to non-albuminoids for the production of milk should not be much wider than 1 : 6.

A nutritive ratio of 1 : 5.2 produced eight per cent. more milk than a ratio of 1 : 9.

A ratio of 1 : 5.6 produced nine per cent. more milk than one of 1 : 8, and a ratio of 1 : 6 produced thirteen per cent. more than a ratio of 1 : 7.

G. H. WHITCHER, *Director.*

Digitized by Google

NOTICE.

The position of Station Entomologist having been filled by t
election of Prof. C. M. WEED, we are now prepared to study the va
ous problems connected with insect depredations, which, at the pr
ent time, are so disastrous to farm crops.

The Station will gladly undertake to identify specimens, if th
are sent to us in some form of package which will insure their arri
in good state of preservation.

Any unusual outbreak of destructive insects will be promptly t
tended to if the Station is notified.

Address all communications to NEW HAMPSHIRE EXPERIMENT ST
TION, HANOVER, N. H.

Digitized by Google

Files
Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL

PERIMENT STATION,

HANOVER, N. H.,

BULLETIN NO. 14.

NSILAGE IN DAIRY FARMING.

MAY 1891.

Digitized by Google

HARVARD COLLEGE
FEB 21 1929
LIBRARY

ENSILAGE IN DAIRY FARMING.

The following Bulletin is put out at this time, not because of the original investigation which it records, but more as an aid to those farmers who may be thinking of adopting the silo as a means of increasing the profits of dairy farming, by decreasing the labor item in the production and storing of the required food.

The present outlook for an abundant hay crop, while not positively discouraging, is not especially flattering, and I have no hesitation, after five years of practical experience with ensilage, in saying that no dairy farmer in the State can afford to be without a silo. Even on the so-called "natural grass farms" a moderate use of ensilage will prove beneficial. Now, if this is true, and I am sure that time will fully demonstrate that it is, then the more rapidly farmers adopt the system the better, and I am led to issue this Bulletin for the purpose of calling the attention of as many as possible to the matter, at a time when it is possible to take immediate steps towards guarding against a shortage in the hay crop.

There is now time to extend the acreage of corn for the silo; even as far north as Hanover we have produced good crops of fair quality when planted as late as June 10th, and certainly throughout the greater part of the State, from the first to the tenth of June would not be too late for ordinary seasons.

ADVANTAGES OF ENSILAGE.

1st. More actual food material can be produced from an acre of corn than from any other of our common farm crops. Land capable of producing two tons of hay will, as a rule, produce twenty tons of ensilage, having at least twenty five per cent. of dry substance, or actual food material.

40,000 lbs. of ensilage equals 10,000 lbs. dry matter.
4,000 lbs. of hay equals 3,000 lbs. dry matter.

It is safe to say, therefore, that three times as much dry substance may be produced from a given area of corn as from a like area of grass.

Digitized by Google

. The cost of a hundred pounds of dry matter is slightly
orn than in hay.
our experience we have found the following figures to be
ially true:

oo lbs. dry matter in *ensilage* cost 42 cents.
oo lbs. dry matter in *hay* cost 44½ cents.

Green food is especially favorable to the production
The succulent pasture grass in May and June is with-
equal as a milk producing food. Mangels and other
hen fed in combination with dry fodders, are known to
very beneficial effect, and with ensilage the same has
served.
an experiment, carried on at this Station, where hay and
were compared, the following averages were obtained:
e ration, containing 16.45 lbs. digestible dry matter, pro-
ed 21 lbs. milk.
ion, containing 16.83 lbs. digestible dry matter, produced
4 lbs. milk.
ere are those who claim that a pound of digestible mat-
ne substance is as good as a pound in any and all other
ces, and that succulence adds nothing to the value of
This I do not regard as proven by practice. In Bul-
o. 11 of this Sation it was shown that one hundred pounds
tible matter in a ration made up of *skim-milk* and *corn*
s equal to 146.6 lbs. of digestible matter in a ration
ly identical, but made up of *corn meal* and *middlings*.
lly, there can be no doubt that a pound of food material
kim-milk ration was superior to a pound in the mixed
tion, and I believe this was due largely to the favorable
on in which the digestive and assimilative organs were
the former ration. This being true of skim-milk, I see
on why pasture grass, roots, or ensilage, may not be like-
re valuable than dried fodders. In fact, I am convinced
ds containing a large per cent. of water keep the ani-
em in such tone that it is able to make better use of the
gested. The efficiency of the steam boiler is very largely
by the deposit of soot on its flues, not that the boiler or
s are changed, or that the combustion of the coal is less
but, rather, that the heat produced by this combustion
tilized in steam making. So, although the same amount

Digitized by Google

of food may be digested in one ration as in another, yet the physiological condition of the animal may be such that this digested matter may in one case be utilized to far better advantage than in another. The problem, then, is not one of efficiency of food so much as of efficiency of the machine, *i. e.*, the animal, and it is this animal efficiency which succulent or watery foods increase. The fact exists, that in every day practice two hundred and fifty pounds of average ensilage will fully take the place of one hundred pounds of hay, *and in most cases the milk yield will increase on this rate of substitution:*

The 250 lbs. of ensilage will contain 41 lbs. digestible matter, while 100 lbs. of hay will contain 51 lbs. digestible matter, or, 100 lbs. of digestible matter in ensilage is fully equal to 125 lbs. in mixed hay, and as the proportion of albuminoids to non-albuminoids is not essentially different, this gain must be due to the condition of the two foods.

4th. Convenience and cheapness of storing: A corn crop having been produced, it must in some way be preserved for winter feeding. "Topping the stalks," binding and stooking them, leaving the ears and butt stalks to dry out, was at one time the prevalent method, but it involved too much hand labor. Stooking the entire crop as soon as the ears are well glazed, and allowing them to dry for a month or more, husking the ears and mowing away the stalks, reduces the labor, but still there is the cost of husking, grinding the grain, etc., which, at the present period of low prices for milk and dairy products, bears too heavily on the raw material item in the problem. To "reduce the cost of production" is the great problem in agricultural progress, and it must be done by reducing the amount of human labor which enters into farm products. A system of stooking corn in large stooks and leaving them in the field until wanted for feeding purposes has been, and is practiced, to some extent, it saves labor, but wastes the crop, and is inconvenient in many ways. Curing the crop and storing is practically impossible on a large scale, since the amount or water to be dried out is very great, and the weather frequently unfavorable; in a small way it can be practiced, but the disadvantages more than offset the advantages. The silo, while not an ideal storage vault, does combine more good points and less bad ones than any method yet devised for preserving the corn crop, for the following reasons:

Digitized by Google

(a). The farmer who has a silo is about as independent of the weather as any man can be. Heavy rain, it is true, will prevent the storage of ensilage, but, aside from rain, nothing interrupts this kind of harvesting; light rain and showers, while making the work disagreeable, do not put a stop to it necessarily, and when once in the silo all danger of imperfect curing, which so often injures the crop harvested in the old way, is past.

(b). The season is practically lengthened from two to three weeks, since it is not desirable to have the corn for the silo much past the "boiling or roasting" stage, hence, a variety may be planted for this purpose, which stands no show for ripening, even one year in ten, and as the later varieties of corn are of larger growth and produce more actual food per acre, this gain is by no means unimportant in the more northern parts of New Hampshire. Again, if from unfavorable weather in May, planting is delayed, as already stated, until the first days of June, there is very little risk connected with the crop for the silo, where a crop for husking would be almost certain to be cut off by the fall frosts.

(d). The early date at which the land is cleared makes it possible to either seed down to grass or winter grain. Corn for the silo should be stored at about the same time at which corn for husking should be stooked, and as the stooked corn must dry out for about a month before husking can begin, it follows, that practically the whole of this time is gained for working the land for the next crop.

(e). The cost of harvesting, provided the crop is planted within reasonable distance of the silo, is reduced to a low point. It is true a large bulk of water has to be handled, and very much depends upon the conveniences for handling; an attempt was made to determine the lowest cost at which ensilage might be handled per acre and per ton with steam power for cutting and elevating into silo, and with an abundance of help, on a two acre field, the average distance of which was seventy rods from the silo, with the following results:

Cutting the corn in field, per acre,		$2.00
Loading and drawing to barn,		3.75
Cutting and packing in silo,		2.40
Use of engine and cutter,		1.25
Yield per acre, 15 tons.	Total cost,	$9.40
Cost, per ton,		62¾

Digitized by Google

The crew consisted of three men cutting, three helping load, three teams, and four men to run the work at the silo. With this crew 24½ tons were put in the pit in 4½ hours.

In 1884, under more favorable circumstances as to distance and location, a seven acre field of corn was harvested with the greatest economy possible, and with the following results per acre:

Cutting and stooking,	$2.16
Drawing in fodder and cribbing corn,	2.56
Husking,	5.00
Drawing corn to mill,	1.50
Grinding,	1.80
Total,	$13.02

While I do not have the exact figures as to the per cent. of dry matter in each crop, yet there was not above 6,000 pounds in the husked crop, as against 7,500 pounds in the crop put in silo. Allowing then a loss of twenty per cent. for fermentation in silo, and no loss in the stored dry fodder, there would be an equal amount of dry substance to feed out.

One hundred pounds of dry matter at time of feeding out would cost, for harvesting alone, 25 cents in the husked crop, and 15⅔ cents in the silo. Add to this the greater efficiency of the dry matter, pound for pound, and it is evident that from an economic standpoint the silo has the advantage.

It may be argued that these results are exceptionally low, but both are equally so, I think, and are fairly comparable, since the labor is charged at the same price in each.

To those who have had experience with both methods of harvesting, it will seem unnecessary to argue that a crop of corn may be disposed of quicker, with less risk on account of weather, and with less actual expenditure for labor, in the silo than in any other way.

KIND OF CORN.

The kind of corn depends upon location. A corn well adapted to southern New Hampshire might be too late for the northern part of the State. The points of importance are: 1st, to get a variety of corn that will have a large per cent. of ears fit to boil by September 5th; 2nd, to get a variety that will produce the largest possible growth, and still meet the first condition.

Digitized by Google

general variety for this State I know of nothing bet-
ne Sanford corn, a white flint corn, intermediate be-
and sweet corn. On good soil and with heavy ma-
have produced twenty-five tons per acre, its average
uld probably be about fifteen tons. It is a leafy corn,
y, keeps well in the silo, and grows very rapidly.

AMOUNT OF SEED PER ACRE.

ary to the practice of many, I have always believed in
ling: One bushel of Southern or Western dent corn,
o sixteen quarts of Sanford, and ten to twelve quarts of
eld corn per acre, have given better results than a less
on poor soil I would use less, but on well fertilized land
quantities are not excessive when planted in rows
apart.

THE SILO.

lay of costly silos is past, and it is this fact alone which
e rapid extension of this system of storage. A wood-
eps its contents with less loss than a stone or cement
y because of the penetration of air through mortar
nt.

lo built independent of the barn, having its own
f, etc., can be built for one dollar per ton of capac-
ve seventy-five tons capacity. Contracts can be let
nstruction of a one hundred ton silo, the contractor
everything, for $100.00. If built in a corner of the
cost of material and labor will be about one-half that
on most farms, where there is lumber, and where much
k can be done by the farm help, this cost can be re-
ost, if not quite, to an actual cash outlay of $25.00.
o, 16x16x25 feet, will hold 100 tons. If built in a barn
uire:

eces studding, 3x8, 25 feet long,	2000 feet
eces, basement sills, 8x8, 17 feet long,	360 feet
ds for inside walls,	3500 feet

boards should not be over seven inches wide, planed
de, and the inside course made to break joints with the
ourse. Matching the boards is not only useless, but an
Common covering boards, free from loose knots, are
ugh, and should not cost over $12.00 per thousand.
cases the barn frame and studding can be partly util-

Digitized by Google

ized, and the above quantity of lumber be considerably reduced. A cement bottom, though not necessary, is desirable.

Don't say "you can't afford to build a silo," it is just the other way, *you can't afford to be without one.*

Don't conclude to wait until next year, build one this year, you can easily find time to do it before haying, and then when the early fall frost hits your corn crop you will have a place where it can be put *at once* and saved.

Don't waste money on a stone or cement silo—unless you want to for the fun of the thing—*a wooden one is better.*

Don't subscribe to the doctrine that ensilage is too watery to be good for anything. *Remember that pasture grass in June has more water in it than ensilage has.*

Don't plant Western corn, or Southern corn, but get some variety that will perfect the kernels and produce a good number of ears.

Don't forget that you can soon double the supply of fodder by adopting this system; *more fodder means more milk, and more milk, more cash.*

THINGS TO BE DONE.

Plant two or three acres more of corn as soon as possible.

Select a place in your barn that is convenient, and see how much lumber, and of what dimensions, will be necessary.

Get the lumber, and at odd times put in a silo, and before the fall frosts come, or *immediately* after, put your corn into it; have it cut into 1½ inch lengths if you can, but if this is too much trouble pack it in whole.

To sum up: DON'T throw this Bulletin aside without thinking the matter over, but consider the subject well, and build a fifty ton silo and try it, the results will convince you.

G. H. WHITCHER, *Director.*

Digitized by Google

Fitts

NEW HAMPSHIRE

AGRICULTURAL

PERIMENT STATION,

HANOVER, N. H.,

BULLETIN NO. 15.

PATENT CATTLE-FOODS.

DECEMBER, 1891.

Digitized by Google

HARVARD COLLEGE
FEB 21 1929
LIBRARY

Digitized by Google

PATENT CATTLE-FOODS.

G. H. WHITCHER.

analyses made by the Station chemist and reported be-
ery suggestive to any one who will observe the large
of so-called "Concentrated Foods" that are piled in
ouses of many if not most of our grain dealers. That
ntities are sold no one can doubt, and we know of in-
here careful men have been deceived and have pur-
nsiderable quantities, even to the extent of a ton or
ome one of these frauds, paying more than $100.00 per
he fact that such an imposition can be practiced nat-
ls to the question, cannot some law be placed on our
hich shall effectually prevent such swindling?
ack horse doctors" and "Concentrated Cattle-Food"
rers are twins, and they flourish, not on the ignorance
, but on that lingering remnant of "old times," which
petre and sulphur the universal cure-all for horses and
o far as their food value is concerned the foods below
are worth only from $20.00 to $25.00 per ton, and
may be relished by cattle, owing chiefly to the salt they
till it would be more economical to buy good corn
dlings, cotton seed, etc., at the market price and then
e necessary salt at market rates, than to pay such prices
ixtures are sold for, and so far as the medicinal claim
ed, we have only to say, that the day will come when
horses will be intelligently treated for diseases, and
reatment of a "Quack" is better, and certainly cheap-
he wholesale use of mixtures of unknown composition.

Digitized by Google

CHEMICAL COMPOSITION.

F. W. MORSE.

Samples of three different cattle-foods, or condition-powders, which have been extensively sold in this State, were bought in the open market and subjected to a chemical analysis. The names of these foods were respectively: Pratt's Food, Weston's Condition Powders, and Climax Food. The results of analysis were as follows:

PRATT'S FOOD.

MANUFACTURED AT PHILADELPHIA, PA.

Price, 75c. per 12 lbs., or $6.00 per 100 lbs.

This food was claimed in the circular to be purely vegetable, to contain no mineral or other poison, and to be neither a medicine nor condition powder. The last claim was well founded, as the following analysis shows. The "food" appears to be wheat middlings, to which has been added some fenugreek and common salt. The analysis shows a composition very much like wheat bran or middlings, with a high percentage of ash owing to the addition of salt.

The composition of wheat middlings is given in comparison with the composition of the "food."

	Pratt's Food.	Wheat Middlings.
Water,	10.77	12.1
Ash,	6.27	3.3
Crude Protein,	14.42	15.6
Crude Fiber,	5.37	4.6
Nitrogen-free Extract,	56.25	60.4
Fat,	6.92	4.0

The composition of middlings is taken from the Experiment Station Record, Vol. 2, No. 12.

Digitized by Google

ater solution of the sample was prepared and the only mineral matter found was common salt, of which the tained 1.9 per cent.

as not possible to determine the amount of fenugreek the odor of which was noticeable.

WESTON'S CONDITION POWDER.

DEPOT IN NEW YORK CITY.

Price, 50c. per package containing 3 lbs.

s was claimed to be a "Medicinal Horse, Cattle and Food." It was also claimed to contain no saltpetre, timony or arsenic, and to be purely vegetable.

appearance, it resembled a mixture of corn meal and eed meal, and it had a saline taste and strong odor of k. Below is its analysis compared with the composi- orn meal:

	Weston.	Corn Meal.
Vater,	10.80	10.9
sh,	8.08	1.5
Crude Protein,	15.53	10.5
Crude Fiber,	3.33	2.1
Nitrogen-free Extract,	56.79	69.6
Fat,	5.46	5.4

figures for corn meal are from Experiment Station Vol. 2, No. 12.

ston's food contains more protein or nitrogenous matter e ash than corn meal.

water solution contained an amount of chlorine equiva- .70 per cent. of common salt, and also showed a trace of c acid. No other mineral matter was found.

CLIMAX FOOD.

MANUFACTURED AT BURLINGTON, VERMONT.

Price, $1.00 per 12½ lbs., or $8.00 per 100 lbs.

e circular claimed that "It is not a medicine, but a con- d food." There were no claims made about its compo-

Digitized by Google

In appearance it resembled a mixture of fine wheat [middlings and wheat screenings, together with a small quantity of caraway or fennel seeds and small bits of a substance like butter-nut or elm bark. It had, like the other samples, a strong saline taste and odor of fenugreek. Its chemical composition was as follows, and is shown in comparison with the figures for cotton-seed meal, which is a really concentrated food, taken from the same source as the figures for middlings and corn-meal.

	Climax.	Cotton seed Meal.
Water,	9.26	8.2
Ash,	18.09	7.2
Crude Protein,	12.74	42.3
Crude Fiber,	5.60	5.6
Nitrogen-free Extract,	53.08	23.6
Fat,	3.23	13.1

This comparison shows that the Climax has only its extremely high percentage of ash to warrant a claim to being a concentrated food. The Climax also contained 5.59 per cent. of sulphur, and in the water solution were found, chlorine, 5.92, sulphuric anhydride, 2.53, and sodium oxide, 8.54 per cent., together with traces of potassium and magnesium and a large amount (qualitatively) of nitric acid. From these data it was calculated that the food might have contained the following substances:

Sodium chloride, or common salt,	9.77 per cent.
Sodium sulphate, or Glauber's salt,	4.50 per cent.
Sodium nitrate, or Chili saltpetre,	3.84 per cent.

From these analyses it it evident that the claims of the manufacturers, with regard to concentrated foods, are without foundation, as neither of the three will approach cotton-seed meal in the percentage of protein and fat. The medicinal substances found are of the cheapest kind. The average price per pound, at which they can be bought in the market, is not so high as the price per pound of the foods.

Fenugreek, the odor of which was very strong in each mixture, is thus spoken of in the *National Dispensary*: "It possesses hardly any other than emollient properties and is used only for poultices."

The *Treasury of Botany* speaks of it as follows: "It is the principal ingredient in most of the quack nostrums, which found

Digitized by Google

favor amongst ignorant grooms and horsekeepers, and is
ısed for flavoring the so-called concentrated cattle-foods,
rendering damaged hay palatable.

conclusion, it is hoped that the people of this State will
ous about paying exhorbitant prices, like $8.00 per one
ponnds, for so-called "concentrated cattle-foods" when
eed and gluten meals can be purchased for one-sixth of
ce, and sulphur, salts, etc., for a few cents per pound.

Digitized by Google

Digitized by Google

Sci 1636.35

The New Hampshire Experiment Station,

HANOVER, N. H.

BULLETIN NO. 16.

EFFECT OF FOOD ON COMPOSITION OF BUTTER FAT.

PART I.—COMMON FEEDING STUFFS.
PART II.—VARIOUS OILS USED IN RATIONS.

SEPTEMBER, 1892.

Concord, N. H.:
Republican Press Association, Railroad Square.
1892.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

EFFECT OF FOOD ON THE COMPOSITION OF BUTTER.

PART I.

In May, 1891, this station issued Bulletin No. 13, in which the above subject was touched upon, but no definite conclusions were given. Since then the work has been carried on as opportunities have occurred, and a variety of rations have been tried with interesting and, we hope, valuable results. Nearly all these rations were such as may be fed on any farm in the state, and an effort has been made to find out that ration which would most probably produce the best butter.

The experiments may be divided into two series. In the first series, constant amounts of hay and ensilage were used in all the rations, while the amounts and kinds of grain were varied. In the second series, the quantities of ensilage and grain remained the same in all rations; but the kind and quantity of hay or dry fodder was changed.

The cows used in the experiments were of different breeds, and were in different stages of lactation; but the influences of those characteristics were either neutralized or accounted for in the end. For convenience the two series will be described separately.

THE FIRST SERIES

was begun May 19, 1891, and continued through the following June and July.

THE COWS

are described in the following table, which shows the arrangement in groups, breed, and length of time in milk:

Digitized by Google

Aurora, 2nd.	Shorthorn.	Milked since March, '91.
Clio.	Ayrshire.	Milked since August, '90.
Duchess of Hanover.	Shorthorn.	Milked since March, '91.
Frost.	Ayrshire.	Milked since Sept., '90.
Chinchilla.	Ayrshire.	Milked since April, '91.
Maramee.	Holstein.	Milked since May, '90.
Duchess.	Shorthorn.	Milked since Sept., '90.
Duchess, 2nd.	Shorthorn.	Milked since June, '90.

THE ANALYSIS OF THE BUTTER

ned to the determination of the volatile, fatty acids and e absorption of the purified butter-fat. This course was ecause the fat is that part of the butter which is least d by the processes of the dairy-man, and therefore best e effect of the food upon the cow. Furthermore, the butter undoubtedly depends in great measure upon the of volatile fatty acids present in the butter-fat, and its has been shown to be closely connected with the amount cid, which in its turn has been shown to be related to nt of iodine absorbed by the butter-fat. In general, a a high flavor has a larger amount of volatile acids than w flavor, and a soft butter absorbs a greater amount of an a hard butter.

THE GROUPS WERE FED

st period of this series, a ration containing mixed grain g of equal parts of corn meal, cotton-seed meal, gluten l middlings. In the second and third periods, groups I ere fed to compare the relative effects of corn meal and al, while groups III and IV were used to find out the cotton-seed meal. After the first three periods, the ere broken by dropping Aurora, Clio, Frost, and Mara- the experiment, and the series was continued with the g cows, individually. But as the cows had been tested lly in the previous periods, as well as in groups, the ould not affect the results.

Digitized by Google

was determined by analyzing a part of them, and by reference to the table in Bulletin No. 4, page 16, for the remainder. The results of the analyses are shown in the following table:

	Water.	Ash.	Crude Protein.	Crude Fiber.	Nitrogen free extract.	Fat.	Nutritive Ratio.
Corn meal.....	14.25	1.15	8.96	1.69	70.19	3.76	1:8.55
Cotton-seed meal...	8.52	6.91	41.44	7.00	23.40	12.73	1:1.35
Cream gluten meal.	8.22	1.84	39.68	1.55	32.59	16.12	1:1.82
*Wheat gluten meal	7.58	1.09	82.72	0.25	7.41	0.95	1:0.12

THE COMPOSITION OF THE RATIONS

is shown in detail in the next table, which gives the amount of food used for a cow weighing one thousand pounds. Each ration is designated at the top of the column by a letter (a, b, c), which serves to distinguish it in the succeeding tables where the effect of the food on the butter is shown:

THE NEXT TABLES

in order give the details of feeding-periods, with the ration fed, the date of taking the sample, the group or cow, and composition of the butter. The figures for volatile acids signify the number of cubic centimeters of deci-normal barium hydroxid solution, which are equivalent to the volatile acids in five grammes of butter-fat. The iodine number means the number of parts of iodine absorbed by one hundred parts of butter-fat. (This explanation of the figures is given for the satisfaction of other chemists who may read this article, and is as clear as can be given in a few words.)

* From Atlantic Starch Works, Brooklyn, N. Y.

Digitized by Google

TABLE OF RATIONS.

Pounds of Food per 1,000 lbs. Live Weight.

n.	a.	b.	c.	e.	g.	h.	j.
.....	40.	40.	40.	40.	40.	40.	.....
.....	5·5	5·5	5·5	5·5	.....	.....	.....
.....	.....	.....	.....	.....	13·5	13·5	.....
.....	2.05	2·35	2·35	2·4	2·35	2·35	2.05
.....	2.05	6.	.....	.....	6.	5.	2.05
l meal	2.05	.....	.....	7·25	.....	.....	2.05
al.....	2.05	.....	5·3	.....	.....	.....	2.05
ten....	.....	.....	.....	.....	.....	15¼ oz.	.....
.....	.....	.....	.....	.....	.....	.....	ad libi-tum.
atio...	1 : 5.2	1 : 8.8	1 : 4.5	1 : 3.9	1 : 7·5	1 : 5·5	1 : 3.4*

TABLE SHOWING EFFECT OF FOOD. GROUPS.

	Ration.	Date of Sample	Group I.		Group II.		Group III.		Group IV.	
			Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.
y	a	June 1	30.2	38.2	32·9	35·0	29.0	39.0	30.8	38·7
	b	" 15	29.6	33·3	.....	.....	.....	.....	.....	.....
	c	" 15	.....	.....	29·3	41·3	.....	.....	.....	.....
	e	" 15	.....	.....	.....	.....	.....	.....	24·4	34·7
	c	" 29	27.1	42.1	.....	.....	.....	.....	.....	.....
	b	" 29	.....	.....	29.0	31.6	.....	.....	.....	.....
	e	" 29	.....	.....	.....	.....	25.4	33·4	.....	.....

* Estimated.

Digitized by Google

TABLE SHOWING EFFECTS OF FOOD. INDIVIDUALS.

Feeding Period.	Ration.	Date of Sample.	Aurora.		Clio.		Duchess of H.		Frost.		Chinchilla.		Duchess.		Duchess, 2d.	
			Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.
Preparatory.	a	June 1	31.4	38.1	26.6	34.8	32.1	33.4	26.4	35.3	28.7	38.3	31.0	36.4	28.9	39.3
June 2	b	" 9	32.0	32.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		" 15	30.1	35.5	24.6	30.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
to	c	" 9	.....	.....	.....	.....	29.4	40.6	.....	.....	.....	.....	.....	.....	.....	.....
		" 15	.....	.....	.....	.....	28.6	41.3	23.8	41.6	.....	.....	.....	.....	.....	.....
June 16.	e	" 9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23.3	34.2
		" 15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23.5	33.7	21.4	34.5
June 16	c	" 23	29.3	42.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		" 29	27.7	40.8	21.5	39.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
to	b	" 23	.....	.....	.....	.....	28.2	33.0	.....	.....	.....	.....	.....	.....	.....	.....
		" 29	.....	.....	.....	.....	29.6	28.8	.....	30.0	.....	.....	.....	.....	.....	.....
July 2.	e	" 23	.....	.....	.....	.....	.....	.....	.....	.....	26.2	33.9	.....	.....	.....	.....
		" 29	.....	.....	.....	.....	.....	.....	.....	.....	26.5	31.9	.....	.....	.....	.....
July 2	g	July 7	.....	.....	.....	.....	29.1	29.8	.....	.....	.....	.....	.....	.....	.....	.....
		" 9	.....	.....	.....	.....	27.5	31.6	.....	.....	.....	.....	.....	.....	.....	.....
to	b	" 7	.....	.....	.....	.....	.....	.....	.....	.....	26.3	26.2	.....	.....	.....	.....
		" 9	.....	.....	.....	.....	.....	.....	.....	.....	24.9	25.7	.....	.....	.....	.....
July 10.	c	" 7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23.6	39.0	25.4	42.3
		" 9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25.1	40.7	27.8	44.8
July 10		" 12	.....	.....	.....	.....	29.2	30.3	.....	.....	.....	.....	.....	.....	.....	.....
	h	" 14	.....	.....	.....	.....	29.5	29.3	.....	.....	.....	.....	.....	.....	.....	.....
to		" 16	.....	.....	.....	.....	29.3	28.7	.....	.....	.....	.....	.....	.....	.....	.....
		" 12	.....	.....	.....	.....	.....	.....	.....	.....	26.6	33.8	.....	.....	.....	.....
July 18.	c	" 14	.....	.....	.....	.....	.....	.....	.....	.....	30.5	36.1	.....	.....	.....	.....
		" 16	.....	.....	.....	.....	.....	.....	.....	.....	31.1	36.1	.....	.....	.....	.....
July 18		" 20	.....	.....	.....	.....	33.1	34.7	.....	.....	29.1	36.7	.....	.....	.....	.....

Digitized by Google

The careful inspection of the table for individuals shows plainly, in the case of the four cows continuing through the experiment, that volatile acids decrease and that the iodine number increases as the period of lactation advances. These facts have been noticed by so many observers that they may be regarded as following a natural law. The inspection also shows the variation in both constituents of the butter from different cows when they are fed upon the same rations. This is especially noticeable in the last series of samples when the cows were at pasture. The variations are due, no doubt, both to peculiarities of breeds or individuals, and to the period of lactation. By referring to the description of the cows it will be seen that Duchess and Duchess, 2d, were of the same breed and in nearly the same stage of lactation. Duchess of Hanover and Chinchilla were also in nearly the same period of lactation, but were of different breeds.

The influence of breed may be left out in studying the effect of the food, but the influence of the period of lactation must be carefully considered.

It has already been mentioned that the rations in this series contained the same quantities of hay and ensilage, but varied in the kind and amount of grain.

IN THE PREPARATORY PERIOD,

as has also been mentioned, the ration (a) contained equal quantities of each grain, and served to show the variations due to breed and period of lactation, and also as a starting point with which to compare the different rations.

CORN MEAL AND GLUTEN MEAL

were fed in rations (b) and (c) respectively, and were used with groups I and II and with the different cows individually. Ration (b) was fed to group I after (a), to group II after (c), and the individuals of the groups, Aurora, Clio, Duchess of H., and Frost, were tested separately at the same time; it was fed to Chinchilla, after ration (e), the cotton-seed meal ration. In no case has it changed the volatile acids from their natural decrease; but in each case the iodine number has been *decreased*, which is *opposed* to the natural progress of lactation and *must be due to the food*.

Digitized by Google

Ration (c) was fed to group I after (b), and to group II after (a), and the cows were also tried individually. In three trials it had no effect on the volatile acids; but the iodine number was increased so sharply that the increase must have been partly due to the food and not wholly to the advance of lactation. It was fed to Chinchilla after (b) and to Duchess and Duchess, 2d, after (e). These trials also showed the same action upon the iodine number, and gave an increase in the volatile acids likewise, which will be further mentioned.

COTTON-SEED MEAL

was fed in ration (e) to groups III and IV after (a), and the individuals of the groups Chinchilla, Duchess, and Duchess, 2d, were compared at the same time. The iodine number was very much *depressed* in each case and the volatile acids also, with the exception of Chinchilla. Now it may be noticed that the increase of volatile acids after feeding gluten meal (c) was in each case preceded by the feeding of cotton-seed meal (e), or (e) and (b).

THESE RESULTS ARE IN ACCORD

with those given in Bulletin No. 13 and therefore our observations all show that corn meal had no effect on the volatile acids; but *lowered* the *iodine number*; gluten meal affected the volatile acids only after they had been depressed by some other food, when it raised them, while the *iodine number* was *raised* in every case; cotton-seed meal *lowered both* volatile acids and iodine number.

GREEN GRASS WAS COMPARED WITH HAY

by feeding rations (g) and (h) after ration (b).

It was tried upon only one cow, Duchess of Hanover. Ration (g) was like ration (b), except that the hay of the latter was replaced by its equivalent of grass. This ration caused no appreciable variation in the butter-fat. Ration (h), which followed ration (g), had a portion of its corn meal replaced by wheat-gluten meal, a nearly pure albuminoid substance. The effect of this ration was to increase the volatile acids slightly; while the iodine number was slightly decreased. Ration (j) contained no grain, consisting wholly of pasture-grass. A study of the samples from three of

Digitized by Google

the four cows, showed no change in either volatile acids or iodine number which could not be attributed to the advance of lactation.

Grass *did not*, in general, *affect* the *composition* of the *butter*, which fact corresponds with recent German investigations.

THE SECOND SERIES

of experiments was begun on January 2d, 1892, with seven cows, and various kinds of hay or dry fodder were compared. The cows were arranged in four sets or groups as follows:

Group I.	Duchess.	Shorthorn.
	Duchess, 2d.	Shorthorn.
Group II.	Pilot's Lily.	Jersey.
	Princess Leto.	Jersey.
Group III.	Maramee.	Holstein.
Group IV.	Chinchilla, Jr.	Ayrshire.
	Frost, Jr.	Ayrshire.

The rations, as before remarked, contained the same kinds and quantities of grain, but varied in the amount and variety of hay. They were calculated from the table in Bulletin No. 4, of this station, and are given in the following table, where each ration is designated by a number at the top of the column:

TABLE OF RATIONS.

Pounds of Food per 1,000 lbs. live weight.

Ration.	1	2	3	4	5	6	7
Ensilage	50	50	50	50	50	40	50
Middlings	2½	2½	2½	2½	2½	2½	1⅔
Gluten meal	1¼	1¼	1¼	1¼	1¼	1¼	.....
Cotton-seed meal	1¼	1¼	1¼	1¼	1¼	1¼	.....
Corn meal	.....	.....	.....	.....	.....	2½	3⅓
Mixed hay	5	.....	.....	10	.....	8	10
Oat hay	5	.....	.....	.....	10	.....	.....
Clover hay	.....	10	.....	.....	.....	.....	.....
Vetch hay	.....	.....	10	.....	.....	.....	.....
Nutritive ratio	1:6	1:5.2	1:4.7	1:6.2	1:5.8	1:6	1:9.8

Digitized by Google

THE FEEDING PERIODS

were three in number, the preparatory period of two weeks, the second period of two weeks, and the third period of four weeks.

THE SAMPLES OF BUTTER

were taken near the ends of the first and second periods, and in the middle and at the end of the third period. Following is the table showing the periods, rations, and composition of the butter, similar to the tables in the first series:

TABLE SHOWING EFFECT OF FOOD.

Feeding Period.	Ration.	Date of Sample.	Group I.		Group II.		Group III.		Group IV.	
			Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.
Preparatory	1	Jan. 12	30.5	34.4	28.9	26.4	31.0	31.5	27.8	32.7
January 14	2	" 27	33.4	33.7	.....	.....	.....	.....	.....	.....
to	3	" 27	.....	.....	29.2	28.3	.....	.....	.....	.....
	4	" 27	.....	.....	.....	.....	32.4	31.8	.....	.....
January 28.	5	" 27	.....	.....	.....	.....	.....	.....	27.4	32.9
January 28	4	Feb. 10	33.2	32.9	.....	.....	.....	.....	.....	.....
		" 24	32.1	36.0	.....	.....	.....	.....	.....	.....
to	6	" 10	.....	.....	30.2	27.7	.....	.....	.....	.....
		" 24	.....	.....	29.4	29.9	.....	.....	.....	.....
February 26.	7	" 10	.....	.....	.....	.....	30.0	30.4	.....	.....
		" 24	.....	.....	.....	.....	30.8	36.0	.....	.....
	2	" 10	.....	.....	.....	.....	.....	.....	28.0	35.7
		" 24	.....	.....	.....	.....	.....	.....	27.5	37.7

In the first five rations there are compared mixed hay or English hay, clover hay, dry oat-fodder, and vetch hay. In the two last rations the nutritive ratio of the mixed hay ration (4) is widened by the addition of corn meal and dropping out gluten meal and cotton-seed meal.

Digitized by Google

or ration (1), contained mixed hay and oat fodder. The variation of the volatile acids and iodine number, due to other causes than food, may be seen in the table, along the first line.

Vetches (3) and oat fodder (5) were tried but once in each case. The former was fed to group II after (1) and the latter was fed to group IV in the same order. Neither produced any apparent change in volatile acids. Clover hay (2) was fed to groups I and IV, and in each case the *volatile acids were increased*, which is contrary to the observed facts for progress of lactation, and should be attributed to the food. In the case of group IV there appears to be but a very slight increase, but in a month the advance of lactation usually lowers the volatile acids appreciably.

Mixed hay (4) was fed to groups I and III. With group III it followed the preparatory ration and *increased* the *volatile acids*; with group I it followed clover hay (2) and kept the volatile acids at the high point to which the clover hay had raised them.

Rations (6) and (7) caused no appreciable change in the composition of the butter-fat from the previous rations, unless the constancy of volatile acids with group II is considered equivalent to an increase, which may be attributed to the mixed hay.

In general, since the *oat fodder* was fed in the preparatory ration and in (5), it appeared in this series that it caused a *lower amount* of *volatile acids* in the butter-fat, than was the case with clover hay or mixed hay.

The sinking of volatile acids and rising of the iodine number with the advance of lactation, was again seen in this series in the last period, where the two samples of butter were taken with an interval of two weeks between them. Group III was an exception in the case of the volatile acids.

There is to be noted in conclusion that some of the results of this scientific investigation are in accord with the practice of many dairy-men who produce a high grade of butter. A favorite ration with them is corn meal and clover or mixed hay.

Corn meal has been shown to produce a butter-fat with a low iodine number, corresponding to a hard, firm butter. Clover hay and mixed hay have produced a butter-fat with a high figure for volatile acids, which is equivalent to a high flavor.

Nevertheless, corn meal and clover hay are not the only suitable foods for producing a firm, highly flavored butter, and the study of this bulletin should show other combinations even better.

Digitized by Google

EFFECT OF FOOD ON THE COMPOSITION OF BUTTER.

PART II.

The experiments described in the following pages were a continuation of those described in Part I, and were carried out for the purpose of throwing some light upon the action of different food constituents, as the proteids or albuminoids, starch and fat, upon the composition of the butter-fat.

THE CONTINUATION OF THE FIRST SERIES

consisted of comparisons of corn meal with gluten meal and corn-starch, and comparisons of whole cotton-seed with cotton-seed meal and cotton-seed oil.

Gluten meal represented the albuminoids of the corn meal, and also contained the fat. The whole cotton-seed was ground to a coarse meal, which therefore contained the lint, hulls, oil, and albuminoids. Cotton-seed meal represented the albuminoids, as the hulls and oil are removed as thoroughly as possible, previous to the grinding. The cows were the same as described in the first part and need no description here.

THE COMPOSITION OF THE FEEDING-STUFFS

has already been given in part, but for convenience in comparing them, they are repeated here in connection with the analysis of the cotton-seed.

Digitized by Google

COMPOSITION OF FEEDING STUFFS.

	Water.	Ash.	Crude Protein.	Crude Fiber.	Nitrogen, free ext' ct	Fat.	Nutritive Ratio.
Corn meal.....	14.25	1.15	8.96	1.69	70.19	3.76	1:8.55
Cream gluten.....	8.22	1.84	39.68	1.55	32.59	16.12	1:1.82
Cotton-seed meal	8.52	6.91	41.44	7.00	23.40	12.73	1:1.35
Cotton-seed.....	7.55	5.00	18.72	22.18	25.27	21.28	1:4.70

The starch was assumed to be pure, as was also the cotton-seed oil, and they were not analyzed.

THE FOLLOWING TABLES

are arranged as in the preceding part, to describe the rations and the results of the different trials. Some of the figures have already been used; but are repeated for greater convenience in studying the experiments.

TABLE OF RATIONS.

Pounds of Food per 1,000 pounds live weight.

Ration.	a	b	c	d	e	f	i	j
Ensilage.....	40	40	40	40	40	40	40	.....
Hay.....	5.5	5.5	5.5	5.5	5.5	5.5	5.5	.....
Middlings.....	2.05	2.35	2.35	2.25	2.40	2.25	2.35	2.05
Corn meal.....	2.05	6.	.....	.....	.....	.....	.....	2.05
Gluten meal.... ...	2.05	.....	5.3	.....	.....	3.5	1.83	2.05
Cotton seed.....	.....	.....	.....	6.25	.....	.....	.....	.....
Cotton seed.....	2.05	.....	.....	.....	7.25	.....	.....	2.05
Cotton-seed oil.....	.....	.....	.....	.....	.....	oz. 13.5	.....	.....
Starch.....	.....	.....	.....	.....	.....	.....	3.4	.....
Pasturage.....	.....	... ..	.....	... ..	.....	.....	.....	ab libitum.
Nutritive ratio.....	1:5.2	1:8.8	1:4.5	1:7.1	1:3.9	1:6.2	1:8.4	* 1:3.4

* Estimated.

Digitized by Google

Feeding Period.	Ration.	Date of Sample	Group III.		Group IV.		Chinchilla.		Duchess.		Duchess, 2d.	
			Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.
Preparatory	a	June 1	29.0	39.0	30.8	38.7	28.7	38.3	31.0	36.4	28.9	39.3
June 2	d	" 9	.....	.....	.....	....	20.6	34.2	....	...	.....	.....
to	d	" 15	19.3	34.7	....	....	21.9	33.6	....	....	.....	.....
	e	" 9	.....	.....	....	....	....	...	....	....	23.3	34.2
June 16.	e	" 15	.....	.....	24.4	34.7	....	.....	23.5	33.7	21.4	34.5
June 16	e	" 23	.....	.....	....	....	26.2	33.9	....	....	.....	.....
to	e	" 29	25.4	33.4	....	....	26.5	31.9	....	....	.....	.....
	d	" 23	.....	.....	....	....	....	.....	....	....	20.1	32.6
July 2.	d	" 29	.....	.....	21.2	32.9	....	.....	18.2	32.0	19.5	30.1
July 2	b	July 7	.....	....	....	....	26.3	26.2	....	....	.....	.....
to	b	" 9	.....	.....	....	....	24.9	25.7	....	....	.....	.....
	c	" 7	.....	.....	....	....	....	.....	23.6	39.0	25.4	42.3
July 10.	c	" 9	.....	.....	....	....	....	.....	25.1	40.7	27.8	44.8
	c	" 12	.....	.....	....	....	26.6	33.8	....	....	.....	.....
July 10	c	" 14	.....	.....	....	....	30.5	36.1	....	....	.....	.....
	c	" 16	.....	.....	....	....	31.1	36.1	....	....	.....	.....
	f	" 12	.....	.....	....	....	....	.....	21.6	35.0	.....	.....
to	f	" 14	.....	.....	....	....	....	.....	18.0	38.3	.....	.....
	f	" 16	.....	.....	....	....	....	.....	19.6	40.2	.....	.....
	i	" 12	.....	.....	....	....	....	.....	....	....	25.3	38.1
July 18.	i	" 14	.....	.....	....	....	....	.....	....	....	27.3	35.0
July 18	i	" 16	.....	.....	....	....	....	.....	....	....	27.9	37.2
to		" 20	.....	.....	....	....	29.1	36.7	17.6	36.9	25.6	38.8
	j	" 24	.....	.....	...	....	29.8	38.2	20.4	40.5	23.6	40.3
July 31.		" 27	.....	.....	....	....	25.3	39.7	19.1	38.2	22.7	39.8
		" 31	.....	.....	....	....	26.5	39.8	22.5	40.4	21.3	41.2

Digitized by Google

THE COMPARISON OF COTTON-SEED

with cotton-seed meal was made upon the groups III and IV, and three of the cows in the groups were tested individually. With group III, the cotton-seed ration (d) preceded the cotton-seed meal (e).

The iodine number was steadily lowered; but, while cotton seed lowered the volatile acids from 29.0 to 19.3, the meal raised them from 19.3 to 25.4; the same phenomenon was also noticed with Chinchilla alone.

With group IV the order was reversed, and there was a steady decrease in both iodine number and volatile acids. The former decrease, as already explained, was contrary to the advance of lactation, while the decrease of volatile acids was so sharp that it must have been partly caused by the food. Comparing the rate of change in both constituents, for each substance, cotton seed influenced the composition of the butter, more than the cotton-seed meal.

CORN MEAL WAS FED

to Chinchilla, in ration (b) after cotton-seed meal ration (e). The figures have already been mentioned, but attention is again called to the lowering of the iodine number and the non-interference with the natural decrease of the volatile acids.

GLUTEN MEAL, RATION (c)

was fed to Duchess and Duchess, 2d, after cotton-seed (d), and to Chinchilla after (b). Part of these figures have been used before, and it will be recalled that the gluten meal increased the iodine number abnormally and also raised the volatile acids, when it followed a food which had caused them to decrease.

COTTON-SEED OIL

was fed in ration (f) combined with gluten meal, and followed gluten meal, ration (c), with Duchess.

There was a decided lowering of the volatile acids, judging by the preceding and following periods, which was apparently due to the oil; but the iodine number was not changed much. Applying

Digitized by Google

the comparison with the preceding and following periods, it appeared to have been, on the whole, slightly retarded from the normal rate of increase.

CORN STARCH

was combined with gluten meal in ration (i) in such proportion that the ration was equivalent to the corn-meal ration (b).

It followed gluten meal (c) with Duchess, 2d, and produced the same effect as corn meal, decreasing the iodine number and causing no variation in the volatile acids.

THE CONTINUATION OF THE SECOND SERIES

was carried out with the cows Duchess, Maramee, and Princess Leto, which were used in the second series of Part I. The experiment consisted of trials of several oils or fats in rations containing a constant quantity of albuminoids and carbohydrates. The oils used in the series were corn or maize oil, cotton-seed oil, cocoanut oil, palm oil, commercial oleo oil, and commercial stearin. Since it was desired to observe especially the effect of corn oil and cotton-seed oil, the ration was compounded with a view to avoiding any of the products of cotton-seed or corn, other than the oils, and for this purpose, clover and vetch hay, oat-meal and middlings, together with ensilage, were used for the preliminary feeding, and the trial rations were made by adding equal quantities of the oils to the preliminary ration.

THE DIFFERENT RATIONS

and the results of the trials are given in the succeeding tables:

Digitized by Google

TABLE OF RATIONS.

Pounds of Food per 1,000 pounds live weight.

ion.	8	9	10	11	12	13	14	15	16
e.....	23½	23½	23½	23½	23½	23½	23½	23½	23½
ay.....	7½	7½	7½	7½	11¼	11¼	11¼	11¼	11¼
ay.....	3¾	3¾	3¾	3¾	.....	.....	.....	.....	.....
l.....	3¾	3¾	3¾	3¾	3¾	3¾	3¾	3¾	3¾
gs.....	3¾	3¾	3¾	3¾	3¾	3¾	3¾	3¾	3¾
l.....	.....	11 oz.	.....	.....	.....	.....	.....	.....	.....
l.....	.....	.....	11 oz.	.....	.....	.....	.....	.....	.....
seed oil.	.....	.....	.....	11 oz.	.....	.....	.....	11 oz.	.....
.....	.....	.....	.....	.....	.....	11 oz.	.....	.....	.....
.. ....	.....	.....	.....	.....	.....	.....	11 oz.	.....	.....
nut oil..	.....	.....	.....	.....	.....	.....	.....	.....	11 oz.
e ratio.	1 : 5.9	1 : 6.7	1 : 6.9	1 : 7	1 : 6.2	1 : 6.9	1 : 7	1 : 7	1:6.9

ng Period.	Ration.	Date of Sample.	Duchess.		Maramee.		Princess Leto.	
			Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.	Volatile Acids.	Iodine Number.
tory.....	8	March 13	33.1	33.0	31.3	33.5	29.0	28.4
arch 16	9	" 27	31.5	34.8	.....	.....	.....	.....
to	10	" 27	.....	.....	.....	.....	28.4	38.1
	11	" 27	.....	.....	25.2	41.9	.....	.....
arch 31.	11	" 31	.....	.....	27.3	43.6	.....	.....
27–31.....	12	" 31	.....	.....	.....	.....	27.6	32.3
arch 31 to pril 16.	13	April 14	28.0	35.6	.....	.....	.....	.....
	14	" 14	.....	.....	.....	.....	30.7	31.6
pril 16 to pril 27.	15	" 27	29.6	37.6	.....	.....	.....	.....
	16	" 27	.....	.....	.....	.....	29.8	24.2
.....		May 26	32.5	35.0	.....	.....	33.8	30.4
		July 4	29.9	39.4	.....	.....	32.7	32.8

Digitized by Google

The inspection of the tables shows some interesting results, but owing to the small number of trials no law can be deduced from them.

PALM OIL.

was fed to Duchess, immediately after the preparatory ration, in ration (9), and there was no change in the volatile acids or the iodine number from the normal progress of lactation. Stearin, ration (15), was next fed and produced no effect on the iodine number, but by comparing the volatile acids with the two preceding periods and with those following, especially the pasture period of July 4, nearly four months after the preparatory ration, it appeared that the volatile acids were decreased. By the same method of comparison, cotton-seed oil in ration (15) raised the iodine number, and while increasing the volatile acids over the stearin ration, did not make them of normal quantity. By the same line of reasoning palm oil had a similar effect to cotton-seed oil, though less noticeable. Cotton-seed oil in ration (11), fed to Maramee after the preparatory period, showed a very decided action upon the volatile acids and iodine number, and in the same direction as when fed to Duchess.

Corn oil was fed to Princess Leto in ration (10) after the preparatory period. There is no effect on the volatile acids, but the iodine number rose abruptly from 28.4 to 38.1. The ration (12) fed to Princess was used because the vetch hay had become exhausted. The only change was in feeding clover hay instead of equal parts of clover and vetch. The result was to bring the iodine number back to a more normal amount. Olein or oleo oil was next fed in ration (14) and produced a decided rise in the volatile acids, while the iodine number was slightly decreased. Cocoa-nut oil followed the olein and caused a sharp decrease in the iodine number. With Princess Leto, the pasture periods show a peculiar condition with regard to volatile acids, inasmuch that they are higher than in any period during the experiment, although from one to two months had elapsed.

SUMMING UP

the results of these trials, it was shown that the volatile acids were only slightly affected, but on the whole were decreased, by feeding

Digitized by Google

omparison of the changes in the butter-fat with the vol- of the fats used in the rations, showed a striking result, mparison is here given :

	Vol. Ac.	*Change in vol. ac. of butter.*	
ut,	6.5	30.7 to 29.8	— 0.9
	3.2	29.0 to 28.4	— 0.6
seed,	1.1	31.3 to 25.2	— 6.1
	1.7	33.1 to 31.5	— 1.6
	2.0	27.6 to 30.7	+ 3.1
	1.4	31.5 to 28.0	— 3.5

ıe exception of the olein, which increased the volatile r the previous ration, the fats caused the volatile acids ter to vary in the order of their own contents of volatile

dine number was more affected by feeding the fats, and ı was a striking coincidence, which is shown in the fol- mparison of the oils and their action.

	Iodine Number.	*Change in iodine number of butter.*	
	112.8	28.4 to 38.1	+ 9.7
seed,	106.1	33.5 to 41.9	+ 8.4
	52.2	33.0 to 34.8	+ 1.8
ut,	7.1	31.6 to 24.2	— 7.4
	47.5	32.3 to 31.6	— 0.7
	24.1	34.8 to 35.6	+ 0.8

comparison it is shown that with the exception of the ats caused the iodine number in the butter to vary in e with their own iodine numbers.

IN CONCLUSION

nd that, of the constituents of corn meal, the gluten or ds had the property of affecting the volatile acids in the while the starch and oil affected the iodine number, decreasing and the latter increasing it. Since gluten ained both oil and albuminoids, and the oil affected the mber as much as the gluten meal did, it was impossible t the albuminoids did or did not act on it.

cotton-seed constituents, it was found that the oil and or nitrogenous part, affected the volatile acids alike ; but number was raised by the oil and lowered by the meal.

Digitized by Google

When fed all together in the original grain, cotton seed produced the effect of the meal or nitrogenous matter; while corn produced the effect of the starch.

These trials with carbohydrates, albuminoids, and fats were not numerous enough to enable one to formulate a new theory from them or to overthrow old theories; but they do not agree with the theory that milk fat is formed from the albuminoids only of the food constituents, and that fats in the food do not enter into the fat of the milk.

F. W. MORSE, *Chemist.*

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL EXPERIMENT STATION,

DURHAM, N. H.

BULLETIN NO. 17.

STOCK FEEDERS' GUIDE,

WITH

CHART FOR USE IN BARN.

STANDARD GRAIN MIXTURES.
STANDARD RATIONS.

OCTOBER, 1892.

Concord, N. H.:
REPUBLICAN PRESS ASSOCIATION, RAILROAD SQUARE.
1892.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NOTICE.

The Agricultural Experiment Station of New Hampshire having been removed from Hanover, N. H., to Durham, N. H., all communications should be directed to the latter place.

The work of laying out the fields and constructing buildings at Durham has prevented the issuing of bulletins, as would otherwise have been done; but we feel confident that the opportunity for work in new lines in our new home will more than compensate for the unavoidable losses the past year.

The old farm having been sold early the past spring, no field work was possible; but the dairy work under Professor Wood, and the chemical work under Professor Morse, have given valuable results which will be published within the coming two months, two bulletins being now in the hands of the printer and a third nearly ready.

The work of equipping our new Laboratory, now nearly ready for occupancy, will be forwarded as rapidly as possible, while the field work will be fully laid out for next season.

G. H. WHITCHER,
Director.

Digitized by Google

STOCK FEEDING.

ubject of winter feeding of live stock is of such vast im.
to the farmer that at this time I venture to once more
ry farmer, young or old, to give it careful study; and, in
that there are many who would like to test a practical yet
method, this Bulletin is sent to about 8,000 New Hamp-
mers, most of whom doubtless own stock of some kind.
designed to give plain, practical points which may be
in part, at least, by every farmer, if he is willing to profit
xperience of men whose business it has been to make
nvestigation of the principles and laws of stock feeding.
is point I want to ask every reader of this Bulletin not to
aside, and say, "Oh, what is the use of feeding by weight
sure? The old way of feeding is good enough." On the
, let me ask you to think for one moment whether or not
onable to suppose that there is room for improvement in
ell as other departments of farm work. How many are
day who mow with the hand scythe, rake with the hand
p with the sickle, or thresh with the flail? There has
at improvement in all the mechanical work on the farm;
t it reasonable to look for corresponding advancement in
ing of the cattle? There has been improvement in the
of farmers in this line, but not in the same degree that
ods of field work have improved. *Farm stock can be*
le, if good judgment is used in carrying out the details.
ng out of a railroad requires a vast amount of work "on
heoretical work; but it takes a lot of common sense and
, every-day shrewdness to decide upon the most feasible
d to overcome obstacles as they appear. So, in feeding,
rules that are reliable, and are the roads to success; but
not infallible, and must be used with good judgment.

Digitized by Google

There are *feeding standards* which tell us how much of the really valuable part of the fodder (*i. e.*, the digestible constituents) is required daily by various classes of stock, and they are based upon actual feeding, and may be depended upon as substantially correct. With these any man may determine for himself what quantity of fuel (that is, food) will be required to get the best results from these living engines which are to produce milk, beef, pork, wool, eggs, etc.

The first step towards profitable feeding, then, is to know the quantity of digestible food required.

The "German Feeding Standards" are of inestimable value to the practical farmer, if only the farmer will make use of them; they give us the daily food required under most of the conditions commonly met with on the farm. The following table is a reprint from Bulletin 4 of this station:

Table A shows the *pounds* of digestible nitrogenous matter (albuminoids) and digestible starchy matter (non-albuminoids) required *daily* for each 1,000 pounds, live weight, of various animals, and the ratio of the former to the latter, known as the Nutritive Ratio.

TABLE A.

1,000 lbs. live weight require daily	Digestible Albuminoids. Lbs.	Non-Albuminoids. Lbs.	Nutritive Ratio.
Oxen at rest	0.7	8.37	1 : 12
Oxen working	2.4	14.45	1 : 6
Oxen fattening	3.0	16.55	1 : 5.5
Cows giving milk	2.5	13.50	1 : 5.4
Horses, light work	1.8	12.70	1 : 7
Growing cattle	2.5	15.00	1 : 6
Sheep, for wool	1.2	10.80	1 : 9
Sheep fattening	3.0	16.45	1 : 5.5
Hogs fattening	4.0	24.00	1 : 6

HOW TO USE THIS TABLE.

The farmer will ask the question, What shall I do with this table? For a concise answer I would say, Use it just as your wife uses her cook book. It gives you the same information relative to feeding a cow that the cook book gives her when she makes cream pie, that is, it tells the amount and kinds of *digestible material* that

Digitized by Google

ought to have to produce good results. It does n't pretend the only combination from which good results may be ed any more than Hood's cook book pretends to have the ombination of cooking materials which will make cream pie, is based on hundreds of practical feeding experiments, and e accepted by any farmer as a good, safe, practical guide to oy; and if every milk producing cow in New Hampshire oe fed this winter by this table, there would be an increase e than one fourth in the milk and butter produced. Now, worth trying?

ILLUSTRATION SHOWING HOW TO USE TABLE A.

or two examples will aid those who want to give this mat-rial:

ose you have a cow whose live weight is 900 lbs., and are for milk. From the table it appears that a 1,000-lb. cow es $2\frac{1}{2}$ pounds of albuminoids, and $13\frac{1}{2}$ lbs. of non-albumi-(starch, sugar, oil, etc.) A 900-lb. cow requires $\frac{9}{10}$ as much. lbuminoids) $\times$ 900 = 2,250.0 $\div$ 1,000 = 2.25 lbs. albumi-required by cow weighing 900; in the same way 13.5 lbs. ouminoids $\times$ 900 = 12,150.0 $\div$ 1,000 = 12.15 lbs. re-) Another example:

weighing 750 lbs. 2.5 $\times$ 750 = 1,875 $\div$ 1,000 = 1.87 d. 13.5 $\times$ 750 = 10,125 $\div$ 1,000 = 10.12 required.

rule then is to multiply the amount found in the table for nd of animal under consideration, by the live weight, and off three places (*i. e.*, divide by 1,000).

live weight of the animal must in most cases be determined d judgment, but right here let me say that a set of scales in rn floor is one of the first steps towards successful farming. this, guesswork gives place to definite knowledge, and g becomes an interesting occupation. With the means at or knowing what is being produced in the field, and what the fodder produces when fed, a man is in position to make m profitable; hence I would say to New Hampshire farm-t a set of scales, either three or five tons, and *use them*. The ggestion is far more important than the first.

Digitized by Google

Now, having determined what is required daily by one or several animals, we must know how to supply that material in the most readily available and cheapest form. To do this we must know the composition of our feeding stuffs, and chemists have given us table B, which supplies that information.

TABLE B.

FEEDING STUFFS.

1,000 lbs. of, contain.	Digestible.		Nutritive Ratio.
	Albuminoids.	Non-Albuminoids.	
Herdsgrass (timothy) hay	3.45	48.71	1:14
Redtop hay	4.74	48.19	1:10
Mixed hay	3.71	47.61	1:12.8
Mixed hay and clover	4.85	46.40	1: 9.5
Salt marsh hay	2.27	45.83	1:20
Clover hay	7.53	43.60	1: 5.7
Vetch hay	9.20	37.67	1: 4
Oat hay	4.85	44.83	1: 9.2
Winter rye hay	10.3	51.7	1: 5
Millet hay	4.67	45.43	1: 9.7
Rowen	6.81	41.74	1: 6.1
Oat straw	1.45	43.31	1:30
Bean vines	5.00	36.45	1: 7.3
Corn stover	2.15	41.38	1:19
Ensilage (Northern corn)	1.47	14.80	1:10
Ensilage (Southern corn)	1.32	12.73	1: 9.6
Ensilage (sweet corn)	1.84	14.92	1: 8
Pasture grass	2.5	10.9	1: 4.4
Green rye	2.00	12.87	1: 6.4
Potatoes	1.42	17.70	1:12.4
Sugar beets	1.5	7.81	1: 6.5
Corn and cob meal	7.13	66.52	1: 9.3
Corn meal	7.78	71.60	1: 9.2
Barley meal	9.54	65.95	1: 6.9
Oats, ground	9.90	58.16	1: 5.9
Buckwheat, ground	7.7	66 71	1: 8.7
Linseed (old process)	28.12	53.21	1: 1.9
Linseed (new process)	28.57	44.30	1: 1.5
Cottonseed meal	31.36	42.26	1: 1.3
Shorts	13.26	52.70	1: 4
Middlings	13.35	57.72	1: 4.3
Gluten	25.14	61.90	1: 2.4
Brewers' grains (wet)	4.73	16.22	1: 3.4
Malt sprouts	18.36	52.18	1: 2.8
Cow's milk (whole)	3.00	14.0	1: 4.6
Skim milk	3.23	6.94	1: 2.1
Butter milk	2.9	4.50	1: 1.5

Digitized by Google

HOW TO USE TABLE B.

The feeder who has accepted the fact that his 900-lb. cow requires 2¼ lbs. of albuminoids, and 12½ lbs. of non-albuminoids, next wants to supply that amount of food material, and he must make it up out of the fodder he has at hand or can buy; and here I want to say that I do not believe in following the rule blindly, or with the idea that it is absolutely accurate, for such is not the case. It is a good safe guide, and reasonably accurate, and to be followed within reasonable limits, but variations are admissible, and often profitable, since the market price of grains and fodders varies, and hence grains which at one time are most profitable to use at another time may not be; here is where the ingenuity of the individual comes into play. A cow should have from 1 to 1½ per cent. of her live weight daily of hay, and about as much of any coarse fodder like straw, corn-fodder, swale hay, etc. With the present high price of hay, owing to a very short crop, it will prove profitable to use but little over the 1 per cent. If ensilage is used, take 5 per cent. of the live weight.

RATION FOR COW WEIGHING 900.

	Albuminoids.	Non-Albuminoids.
10 lbs. mixed hay furnish	0.37 lbs.	4.76 lbs.
10 lbs. corn fodder furnish	0.21 lbs.	4.13 lbs.
3 lbs. corn meal (2 quarts)	0.23 lbs.	1.99 lbs.
3 lbs. cotton seed (2 quarts)	.97 lbs.	1.26 lbs.
1½ lbs. gluten (1 quart)	.37 lbs.	.93 lbs.
Total	2.15 lbs.	13.07 lbs.
Required by standard	2.25 lbs.	12.15 lbs.

At present prices this ration would cost about 18 cents, and a trial of this one ration would convince most farmers, I am sure, that it pays to know what we are feeding.

RATION CONTAINING ENSILAGE.

Ensilage, 40 lbs.	0.60 lbs.	5.6 lbs.
Hay, 5 lbs.	0.19 lbs.	2.4 lbs.
Middlings, 4 lbs. (3½ quarts)	0.54 lbs.	2.3 lbs.
Corn meal, 2 lbs. (1½ quarts)	0.14 lbs.	1.3 lbs.
Gluten, 3 lbs. (2 quarts)	0.76 lbs.	1.8 lbs.
Total	2.23 lbs.	13.4 lbs.
Required	2.25 lbs.	12.15 lbs.

Digitized by Google

In each case above given the method of adjusting the ration is simply to decide upon some quantity of hay, say 10 lbs. Now from Table B it will be seen that 100 lbs. of mixed hay contain 3.7 lbs. of albuminoids, and 47.6 lbs. of non-albuminoids, and 10 lbs. would contain 0.37 lb., and 4.76 lbs. as given in ration. The same method holds for other constituents of the ration. The object desired is to get together a combination from the table which shall give a total of digestible albuminoids and non-albuminoids equal to that shown by the feeding standard. There are a few things which must be kept in mind in preparing rations: 1st, there must be bulky fodder, hay, ensilage, or coarse fodders; the rules above given will insure this. 2d, the other constituents must be palatable, and the market price must be taken into consideration as well. It follows then that one of the most important things for the farmer to consider is the kind of grain to buy, for much of the grain that will be fed must be bought.

An important point in figuring a ration is to keep the proportion between albuminoids and non-albuminoids close to the standard of 1 to 5½, though in this country of cheap corn we may with profit make this 1 to 6, or even 1 to 6½; but at once the trouble is seen, if we try to use corn meal in too large quantities, because it is deficient in albuminoids, just as hay and ensilage and corn fodder are; but cotton-seed meal, gluten, middlings, and shorts are all rich in albuminoids, and here is where we must look for something with which to make up the deficiencies of our common fodder. Consequently it will prove more profitable to supplement our home-raised fodders with these highly nitrogenous foods. If for each hundred of corn meal bought farmers would buy one hundred weight of either cotton seed or gluten, and one hundred of middlings or shorts, there would be a great gain in results.

In conclusion, let me ask every reader of this Bulletin to try just for one week a ration like those given, or, what would be better still, figure out one for himself, and see if it pays. Do n't say that rations based on the Feeding Standards are worthless unless you have tried them and found them failures.

Do n't say they are not worth trying; it won't cost you anything to prove for yourself whether or not they are as good or better than the ration you are now feeding.

Digitized by Google

If the Bulletins of this or any other experiment station are to be of any value to the farmers, it must be by making use of the suggestions which they contain; and I hope that this one may be the means of helping to a better understanding of the principles which govern the feeding of farm animals.

The accompanying chart is designed to be placed in some convenient place *in the barn*. It contains information, tables, etc., which will enable any one to figure out rations with a little study and effort; and its use means better results in nine cases out of ten. Do n't leave it in the house; hang it up where you can see it every time you feed your cattle, and see if you cannot make it worth dollars and cents to you this winter.

The "Standard" mixtures given in the chart have been thoroughly tested, and are known to be well suited to New Hampshire, and by using them the work of the feeder is made easy.

I also reprint from Bulletin No. 4 full instructions for making a balance to weigh hay on. It is simple, not expensive, and does its work to perfection. Let the boys make one and try it.

Or, if a little more expense is not objectionable, buy a dial spring scale; then take six laths, and make a frame similar to the one described in the appendix, using cords to suspend it from the four corners in the same way, cover with coarse cotton cloth, and hang on the hook of the dial scale above mentioned. This is a more convenient form of weighing apparatus, and if any farmer in the state wants such a device, the Station will undertake to furnish them at a cost not to exceed $2.50 complete, and less if possible. I hope there will be a hundred farmers who will, in some way, provide themselves with the necessary tools for feeding weighed and measured rations this winter, and note the results.

The scale above mentioned can also be used to weigh the milk of each cow, thus enabling any one to know exactly what results are obtained from the use of any particular ration.

STANDARD GRAIN MIXTURES.

No. 1.		No. 2.	
Corn meal,	100 lbs.	Corn meal,	200 lbs.
Middlings,	100 "	Middlings,,	400 "
Cotton-seed,	100 "	Gluten,	300 "

Digitized by Google

No. 3.		No. 4.	
Corn meal,	300 lbs.	Corn meal,	200 lbs.
Cotton-seed,	300 "	Cotton-seed,	300 "
Gluten,	150 "	Shorts,	300 "

No 5.		No. 6.	
Gluten,	100 lbs.	Gluten,	100 lbs.
Cotton-seed,	100 "	Cotton-seed,	200 "
Shorts,	100 "	Shorts,	100 "

STANDARD RATIONS FOR COWS WEIGHING 1,000 LBS.

No. 1.		No. 2.	
Hay,	11 lbs.	Hay,	11 lbs.
Corn fodder,	11 "	Corn fodder,	11 "
Grain mixture	No. 3, 9¼ lbs., or 7 qts.	Grain mixture	No. 4, 10½ lbs., or 10½ qts.

No. 3.		No. 4.	
Hay,	12 lbs.	Hay,	12 lbs.
Oat straw,	8 "	Oat straw,	8 "
Grain mixture	No. 3, 9 lbs., or 7 qts.	Grain mixture	No. 4, 10 lbs., or 10 qts.

No. 5.		No. 6.	
Ensilage,	50 lbs., or two bushels.	Ensilage,	50 lbs., or 2 bushels
Hay,	5 lbs.	Hay,	5 lbs.
Grain mixture	No. 3, 7½ lbs., or 5½ qts.	Grain mixture	No. 4, 8 lbs., or 8 qts.

No. 7.		No. 8.	
Ensilage,	30 lbs., or five pecks.	Ensilage,	30 lbs., or five pecks.
Hay,	10 lbs.	Hay,	10 lbs.
Grain mixture	No. 3, 8 lbs., or 6 qts.	Grain mixture	No. 4, 9 lbs., or 9 qts.

No. 9.		No. 10.	
Ensilage,	40 lbs., or seven pecks.	Ensilage,	50 lbs. or two bushels.
Clover hay,	8 lbs.	Clover hay,	5 lbs.
Grain mixture	No. 1, 8 lbs., or 6 qts.	Grain mixture	No. 3, 7 lbs., or 5½ qts.

No. 11.		No. 12.	
Ensilage,	40 lbs., or seven pecks.	Hay,	10 lbs.
Clover hay,	8 lbs.	Straw,	10 "
Grain mixture	No. 2, 8¼ lbs., or 6 qts.	Grain mixture	No. 5, 9 lbs., or 9 qts

Grain mixtures Nos. 5 and 6 should only be fed with very coarse fodders, like straw, swale hay, corn fodder, etc.

G. H. WHITCHER, *Director.*

Digitized by Google

APPENDIX.

Reprint from Bulletin No. 4.

It is difficult for many to weigh hay, corn fodder, straw, etc., for lack of suitable scales, but this is by no means a serious matter; for less than $1.00 outlay of cash and ½ day's work a balance can be made that will weigh very accurately. The cuts on page 14 represent the parts of one that is now in use in our feeding barn. Figure 1 is the complete balance; A is the beam; a, a, a, are the pivots, which consist of "screw eyes;" b, b, b, are common "halter snaps," which hook into these screw eyes. The cords which suspend the weight platform (W) and the spreader (h) pass through two of these "snaps" while the hook or cord by which the whole is suspended from a beam (d in the cut Fig. 1) is attached to the third "snap." The platform (P) is suspended by its four corners by cords passing *through* the spreader (h) at the parts marked 2, 3; the spreader being suspended by the cord shown passing through holes at 1 and 4. C is a plumb bob suspended from near the top of the beam at n, and when balanced should be in the center of the board x that is fastened to the center of the beam.

The material from which to construct such a balance consists of three "screw eyes" and three "halter snaps;" these may be had at any hardware store, also 40 ft. of window-weight cord and cloth or canvas to cover the hay platform; this is all that need be bought, and the whole cost is only 35 cents.

The beam is made of a straight piece of inch board, 4 inches wide and 8 ft. 6 inches long. This is shown in Fig. 5. On the under side of this, at each end, a piece is cut out, 6 inches long and 2 inches wide, as shown; on the *top* side, in the *exact center*, one screw eye is inserted; now measure *exactly* 4 feet each way from this to

Digitized by Google

the points y, z, (Fig. 5,) and insert a screw eye at each end on the *under* side, and this completes the beam.

Next get out two pieces, each 1 inch thick, 4 inches wide, and 5 ft. 8 inches long, like Fig. 4, and cut the ends as shown; these are the pieces o, o, which cross in Fig. 2; cross them at right angles and nail securely; now take four laths (t, t, t, t, Fig. 2), cut two of them 4 ft. long, and two 3 ft. 9 inches long. The cross-piece (o) which is *underneath* must have two blocks of inch board, 4 inches square, nailed to each end, to bring the top up even with the other cross-piece. Now nail the laths on as shown. This is the skeleton of the platform, which is to be covered with heavy cotton cloth, or canvas, or oil cloth, tacked to the lath frame; ⅜ inch holes are bored, one in each corner, and through this the window cord will pass. The spreader (h) is shown on a larger scale in Fig. 6; it is made from a rake stale and is 3½ ft. long; four holes are bored in this, two (1 and 4 in cut) are three inches from the ends, the spreader bail-cord passes through these. The other two are 9 inches from the end, and are at *rightangles* to the two first mentioned; through these (2 and 3 in Fig. 6) the cords which suspend the platform are to pass.

Fig. 3 is simply a piece of inch board, 1 foot square, with holes in each corner. On this platform the weights are to be put. The cuts show how the cords are arranged; where the spreader bale passes through the halter snap it must be tied, so that it cannot slip through the ring of the snap. It is very important that the distance between the center screw eye and the end ones shall be *exactly alike.*

When the whole is completed it may be suspended from a beam in the barn floor by a rope, and if it is desirable this rope may pass through a pulley on the beam, and when the balance is not in use it may be *drawn up* out of the way, being lowered on to the floor when needed.

I was three hours in building the one we are using, and most farmers, or their boys or hired men, can build one without having a carpenter to do the work. The cost will then be less than fifty cents. Surely this sum need not prevent any one knowing what he is feeding.

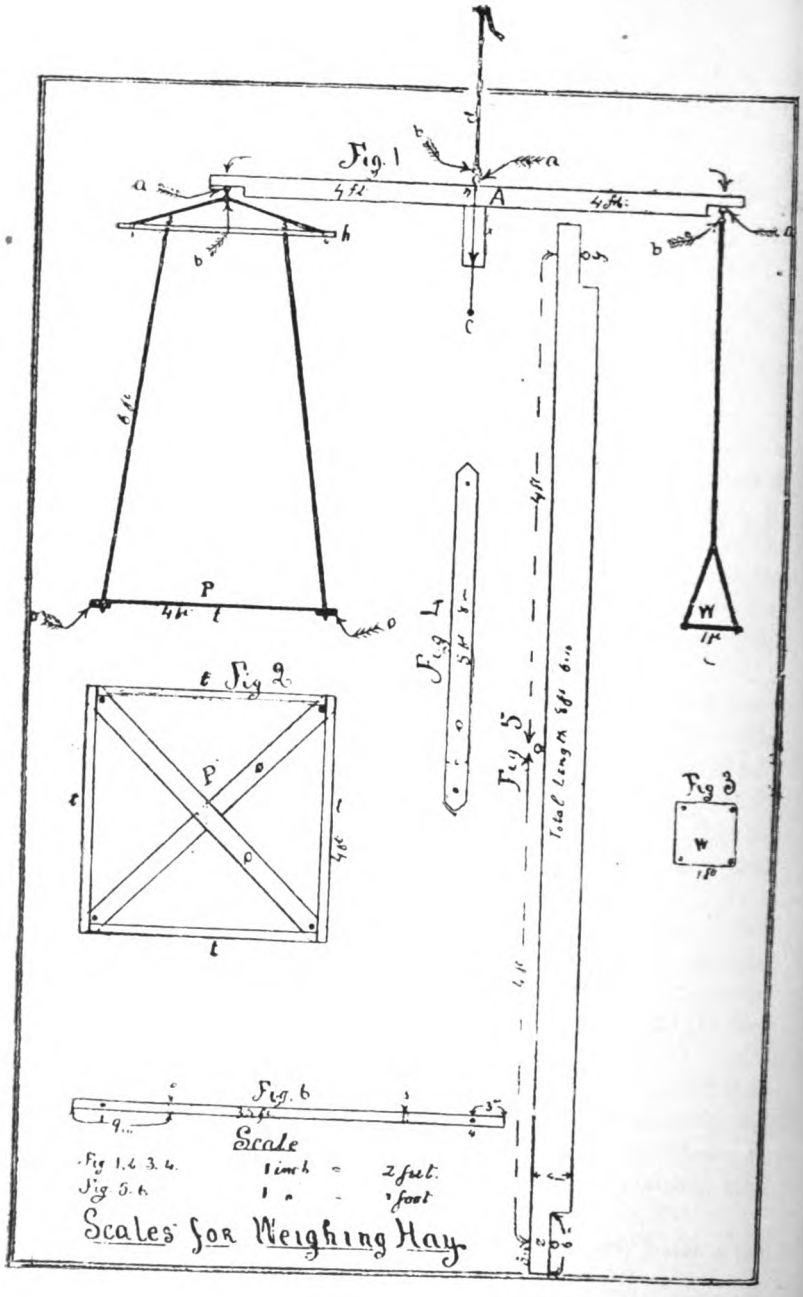
When the whole is complete two bricks will nearly balance the

Digitized by Google

hay platform. It then becomes necessary to have weights from which various combinations may be made. Two bricks may be selected that will weigh 4 pounds each; another may be broken thus getting, by a little chipping, a 2-pound weight; also a piece can, with a small amount of work, be made to weigh 1 pound. With these, even pounds from 1 to 11 can be made out.

I have just carefully tested the balance we are using and find it sensitive to ½ ounce. The grain rations may be weighed on the same balance or they may be measured. The former is more accurate but not quite as convenient.

Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE

AGRICULTURAL EXPERIMENT STATION,

DURHAM, N. H.

BULLLETIN No. 18.

FFECT OF FOOD ON MILK.

NOVEMBER, 1892.

CONCORD, N. H.:
IRA C. EVANS, PRINTER, 13 AND 15 CAPITOL STREET.
1893.

CABOT SCIENCE LIBRARY

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

Digitized by Google

Experiments in Feeding for Milk and Butter.

A. H. WOOD.

During the winter of 1891 and 1892 experiments were carried on to determine the effect of some of the coarse fodders upon the quantity and quality of milk, and also upon the resulting butter product.

Ten cows were selected from the station herd and grouped as indicated in the following table. The table also shows the breed, length of time since calving, and approximate weight.

	Name.	Breed.	Last calf.	Weight.
Group 1.	Duchess.	Durham.	Nov. 9, '91.	1,100 pounds.
	Duchess, 2d.	Durham.	Dec. 22, '91.	1,000 "
Group 2.	Princess Leto.	Jersey.	Oct. 22, '91.	900 "
	Pilot's Lily.	Jersey.	Sept. 19, '91.	1,000 "
Group 3.	Frost.	Ayrshire.	Sept. 24, '91.	900 "
	Maramee.	Holstein.	Oct. 14, '91.	1,200 "
Group 4.	Chinchilla, Jr.	Ayrshire.	July 21, '91.	1,000 "
	Frost, Jr.	Ayrshire.	July 17, '91.	900 "
Group 5.	Maid of Arlis.	Ayrshire.	June 23, '91.	1,000 "
	Nora, 2d.	Durham.	June 21, '91.	1,200 "

During the first two weeks all of the cows were fed upon the following ration per 1,000 pounds live weight:

			—Digestible—	
			Albuminoids.	Non-albuminoids.
Ensilage	50 lbs., furnishing		.73 lbs.	7.40 lbs.
Mixed hay	5 "	"	.24 "	2.24 "
Oat hay	5 "	"	.18 "	2.38 "
Middlings	1⅔	" .22		.96
Gluten	1⅔ 5 lbs.	" .56	1.30 "	1.03 2.69 "
Cotton-seed meal,	1⅔	" .52		.70
		2.45		14.71

Digitized by Google

This ration has a nutritive ratio of 1 to 6, or, to state
matter more fully, it furnishes one pound of digestible albu
noids to six pounds of digestible non-albuminoids.

Analyses of the milk of the different cows were made da
and in the following tables the daily yield of milk and its
cent of fat are averaged for the entire period.

At the close of the preliminary period, group 1 had clo
hay substituted for mixed and oat hay; in period 3, mi
hay took the place of clover; and in period 4, they retur
to the preliminary ration.

Table 1 shows how these changes affected the suppl
albuminoids and non-albuminoids, and hence the nutri
ratio; also the average daily yield of milk, and its per c
of fat.

TABLE 1.

	Period.	Ensilage.	Mixed hay.	Oat hay.	Clover hay.	Mixed grain.	Albuminoids.	Non-albuminoids.	Nutritive ratio.	Average daily yield of milk.	Average per cent of fat.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.	
Duchess	1	55	5½	5½	....	5½	2.61	16.17	1:6.0	34.00	3.91
	2	55	....	....	11	5½	3.05	15.88	1:5.2	35.10	3.94
	3	55	11	....	....	5½	2.63	16.33	1:6.2	32.99	4.03
	4	55	5½	5½	....	5½	2.69	16.17	1:6.0	30.17	4.12
Duchess, 2d	1	50	5	5	....	5	2.45	14.71	1:6.0	39.11	4.03
	2	50	....	....	10	5	2.78	14.45	1:5.2	36.44	3.91
	3	50	10	....	....	5	2.40	14.86	1:6.2	35.79	3.78
	4	50	5	5	....	5	2.45	14.71	1:6.0	35.05	3.66

Duchess, 2d, was slightly off feed during the last few day
period 1, and the first few days of period 2, which will expl
the rather sharp decrease in her yield of milk.

Group 2 received vetch hay in period 2; in period 3, mi
hay replaced the vetch hay, and the quantity of both ensil
and dry fodder was reduced one fifth, corn meal taking its pla
Table 2 shows the variations in the rations of group 2, and
results.

Digitized by Google

TABLE 2.

	Period.	Ensilage.	Mixed hay.	Oat hay.	Vetch hay.	Mixed grain.	Corn meal.	Albuminoids.	Non-albuminoids.	Nutritive ratio.	Average daily yield of milk.	Average per cent of fat.	Caseine per cent.
		lbs.	lbs.	lbs.	lbs.	bs.	lbs.	lbs.	lbs.		lbs.		
s Leto.....	1	45	4½	4½	....	4½	....	2.21	13.24	1:6.0	23.18	5.23	3.45
	2	45	....	....	9	4½	....	2.66	12.47	1:4.7	22.76	5.32	4.16
	3	36	7½	....	....	4½	2¼	2.14	12 79	1:6 0	22.74	5.16	3.53
	4	45	4½	4½	....	4½	....	2.21	13 24	1:6.0	21.13	5.23	3.22
Lily.....	1	50	5	5	....	5	....	2.45	14.71	1:6.0	19.73	5.19	3.65
	2	50	....	....	10	5	....	2 95	13.86	1:4.7	19.58	5.36	3.77
	3	40	8	....	....	5	2½	2.37	14.19	1:6.0	20.05	5.22	3.73
	4	50	5	5	....	5	....	2.45	14.71	1:6.0	18.75	5.29	3.69

e only trial of vetch hay was made with this group, and sult shows it to be equal to, or better than the mixture of nd oats. Vetch hay is so rich in albuminoids that it t be combined with advantage with foods poorer in inoids than were used in this trial. Reference to the will show that the substitution of it, in place of mixed nd oat hay narrowed the nutritive ratio from 1 : 6 to 1 : 4.7, at we cannot say that the result fairly exhibits its compar- value as a food.

period 3 the substitution of corn meal for a part of the e fodder gave good results in that it not only held in the natural decrease in yield of milk, but caused a t increase. It would seem to indicate that when prices rain and dairy products are in favorable relation, a ier grain ration than that ordinarily fed by our farmers be fed to good advantage.

oup 3 in period 2 received mixed hay. In period 3, corn was substituted for the gluten and cotton-seed meal, thus y approaching a ration fed by a great number of our New pshire farmers.

CORNELL UNIVERSITY LIBRARY

Digitized by Google

TABLE 3.

	Period.	Ensilage.	Mixed hay.	Oat hay.	Middlings.	Gluten.	Cotton-seed meal.	Corn meal.	Albuminoids.	Non-albuminoids.	Nutritive ratio.	Average daily yield of milk.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.
Frost.....	1	45	4½	4½	1½	1½	1½	....	2.21	13 24	1:6.0	30 50
	2	45	9	....	1½	1½	1½	....	2.15	13 36	1:6.2	31 52
	3	45	9	....	1½	....	....	3	1.41	13 95	1:9.8	25 64
	4	45	4½	4½	1½	1½	1½	....	2.21	13.24	1:6.0	24.42
Maramee.....	1	60	6	6	2	2	2	....	2.94	17 65	1:6 0	30 45
	2	60	9	....	2	2	2	....	2 87	17 82	1:6.2	31 31
	3	60	9	....	2	....	....	4	1.89	18.61	1:9.8	28.32
	4	60	6	6	2	2	2	....	2.94	17.65	1:6.0	26.39

A study of table 3 will show the reader how r
change in the relation between albuminoids and n
minoids is brought about by so simple a change in
the substitution of corn meal for gluten and cotton-se
The digestible albuminoids are reduced one third, w
digestible non-albuminoids are slightly increased
nutritive ratio widened in consequence from 1 : 6.2 t
The effect of such a change in cows giving milk wa
in a sharp falling off in the yield of milk. To sh
great this shrinkage was, we will make a comparis
the eight cows in groups 1, 2, 4, and 5:

Daily average yield of eight cows in groups 1, 2, 4, and 5 during period 2 2
Daily average yield of eight cows in groups 1, 2, 4, and 5 during period 3 2

Average shrinkage . . . . . .
Daily average yield of two cows in group 3 during period 3 3
Daily average yield of two cows in group 3 during period 3 2

Average shrinkage . . . . . .

Digitized by Google

Or, stated in another way, the cows in the four groups fed upon normal rations during periods 2 and 3 gave three and eight tenths per cent less milk per day during period 3 than during period 2, while the two cows in group 3 fed upon what ought to be considered an abnormal ration gave during period 3 fourteen and one tenth per cent less milk during period 3 than during period 2. If the two cows in group 3 had shrunk in the same proportion as the cows in the other four groups, their shrinkage would have been 1.19 pounds, leaving a shortage of 3.24 pounds, or a quart and a half of milk per cow directly chargeable to wrong feeding. We do not wish in this connection to be understood as condemning corn meal as a dairy food. It is a very valuable food when fed in connection with fodders rich in albuminoids, as clover hay, such grains as peas and oats or the highly nitrogenous by-fodders, cotton-seed, linseed, and gluten meals; but to make it the chief grain food with coarse fodders furnishing ample supplies of non-albuminoids but deficient in albuminoids, is simply inexcusable.

Coming now to group 4, we find the changes to have been to oat hay in period 2, in period 3 oat hay is replaced by clover hay, and in period 4 they returned to the original ration. Table 4 shows the results from these changes.

TABLE 4.

	Period.	Ensilage.	Mixed hay.	Oat hay.	Clover hay.	Mixed grains.	Albuminoids.	Non-albuminoids.	Nutritive ratio.	Average daily yield of milk.	Average per cent of fat.	Casein per cent.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.		
Chinchilla, Jr.....	1	50	5	....	....	5	2 45	14.71	1:6.0	17.80	4.32	3.17
	2	50	....	10	....	5	2.51	14 57	1:5.8	17.11	4.48	3.57
	3	50	....	....	10	5	2.78	14.45	1:5.2	17.17	4.37	3.70
	4	50	5	....	....	5	2.45	14.71	1:6.0	16.52	4.19	3.5
Frost, Jr.....	1	45	4½	....	....	4½	2.21	13.24	1:6.0	23.65	4.02	2.96
	2	45	....	9	....	4½	2.26	13.12	1:5.8	23.79	4.14	2.93
	3	45	....	....	9	4½	2 50	13 00	1:5.2	24.12	4.08	3.15
	4	45	4½	....	....	4½	2.21	13.24	1:6.0	21.53	3.78	3.04

Digitized by Google

Group 5 changed at the beginning of period 2 from the preliminary ration to one containing only one half as much ensilage, receiving in its place corn stover and corn and cob meal. The stover and meal fed were from corn exactly like that put in the silo, and as nearly as we could calculate the amount fed was equivalent to the reduction in ensilage. In period 3 the change from ensilage to dry stover and corn and cob meal was made complete. In period 4 ensilage replaced the stover and meal.

TABLE 5.

	Period.	Ensilage.	Mixed hay.	Oat hay.	Sanford corn stover.	Mixed grains.	Sanford corn and cob meal.	Albuminoids.	Non-albuminoids.	Nutritive ratio.	Average daily yield of milk.	Average per cent of fat.
		lbs.	lbs.	lbs.	lbs.	lbs.		lbs.	lbs.		lbs.	
Maid of Arlis.....	1	50	5	5	....	5	....	2.45	14.71	1:6	22.98	4.07
	2	25	5	5	4	5	1¾	2.45	14.71	1:6	22.30	4.11
	3	....	5	5	8	5	3¼	2.45	14.71	1:6	18.36	4.34
	4	50	5	5	....	5	....	2.45	14.71	1:6	16.69	4.11
Nora, 2d.....	1	60	6	6	....	6	....	2.94	17.65	1:6	26.37	4.24
	2	30	6	6	5	6	2	2.94	17.65	1:6	28.41	4.18
	3	....	6	6	10	6	4	2.94	17.65	1:6	26.66	4.26
	4	60	6	6	....	6	....	2.94	17.65	1:6	26.52	4.13

We have assumed that the digestible nutrients furnished in the rations fed during periods 2 and 3 were equal in amount to those fed during periods 1 and 4, but they may not have been so exactly. The reduction in the amount of ensilage fed in period 2 was accompanied with a slight shrinkage in milk in the case of Maid of Arlis, not, however, more than would have been expected if her ration had remained as before; while in the case of Nora, 2d, there was a positive increase of one quart per day. The effect of changing wholly to dry food in period 3 was a shrinkage in the yield of Maid of Arlis of nearly two quarts and in Nora, 2d, of nearly one quart per day. The return to ensilage in period 4 kept the yield of Nora, 2d, almost constant, while that of Maid of

Digitized by Google

Arlis continued to decrease, but not as rapidly as in the preceding period. We cannot draw any definite conclusions from these results, as there is uncertainty regarding the equivalence of the different rations; but they may serve to indicate that the most profitable use of ensilage may not consist in making it the almost exclusive coarse fodder in a milk ration.

We may now consider the relative effects of clover, vetch, oat, and mixed hays when fed in combination with such foods as were used in these experiments. The data are not very extensive, but we will present them at this time trusting that they will be of value to some of our farmers. Referring to the preceding tables, we gather the following results:

CLOVER.

	Gain. lbs.	Loss. lbs.
Duchess, period 2, mixed and oat hay to clover .	1.10	
Duchess, 2d, " " " " " .		2.65
Chinchilla, Jr., period 3, oat hay to clover . .	.06	
Frost, Jr., " " " " . .	.33	
Duchess, period 3, clover to mixed hay . .		2.11
Duchess, 2d, " " " " . .		.65
Chinchilla, Jr., period 4, clover to mixed and oat hay		.65
Frost, Jr., " " " " "		2.59

With one exception, changing *to clover* not only checked the natural decrease in milk yield, but gave a slight increase. In the exceptional case of Duchess, 2d, it is to be remembered that she went off feed just at the close of period 1, so that the shrinkage in her case cannot be charged up against clover. Again the changes *from clover* are in every case accompanied by a loss, in two instances, Duchess and Frost, Jr., surely beyond the natural decrease. We can safely say that clover certainly demonstrated its superiority over the other hays as a supplement to ensilage.

Digitized by Google

VETCH.

Princess Leto, period 2, mixed and oat hay to vetches
Pilot's Lily, " " " " "

Princess Leto, period 3, vetch hay to mixed hay and corn meal . . . . . .
Pilot's Lily, period 3, vetch hay to mixed hay and corn meal . . . . . .

The vetch hay certainly proved itself to be a good there can be little doubt but that it would show t advantage in combination with foods of a wider nutrit since 1 : 4.7 is narrower than common experience h to be most profitable.

MIXED HAY.

Duchess, period 3, clover to mixed hay . . .
Duchess, 2d, " " " " . . .
Frost, period 2, mixed and oat hay to mixed hay .
Maramee, period 2, mixed and oat hay to mixed hay . . . . . .

Duchess, period 4, mixed hay to mixed and oat hay
Duchess, 2d, " " " " "

Whenever there was a change from mixed and o the mixed hay alone, there was an increase in milk y when the changes were from mixed hay to mixed and there was a loss; so it would seem that the mixed hay and clover) gave better results than did oat hay, alt one instance (Frost, Jr., period 2) there was a gai change from mixed and oat hay to the oat hay alone.

Digitized by Google

OAT HAY.

	Gain. lbs.	Loss lbs.
Chinchilla, Jr., period 2, mixed and oat hay to oat hay		.69
Frost, Jr., period 2, mixed and oat hay to oat hay	.14	
Chinchilla, Jr., period 3, oat hay to clover	.06	
Frost, Jr., " " " "	.33	

While oat hay gave rather less favorable results than did the other fodders, it nevertheless makes a fair showing.

CHANGES IN THE QUALITY OF MILK.

What was the effect of these various changes in the character of the food upon the quality of the milk? To the consideration of those who believe that the fat contents of milk can be materially varied by changes in the character of the food given cows, I would commend an inspection of the average percentages of fat as given in the preceding tables. That there are variations in the amount of fat in the milk when we compare period with period, is true, but it does not follow that these variations are due to the source of the cow's food.

It has been proven that a ration containing about two and one half pounds of digestible albuminoids and about thirteen and one half pounds of digestible non-albuminoids, is essential to maintain a cow, giving milk and weighing one thousand pounds, in a normal condition — that is, to keep her in good bodily condition and maintain a full flow of milk. Such a ration we may well call a normal or balanced ration. These figures are not arbitrary, within reasonable limits they may be varied without serious results, and perhaps sometimes with positive advantage. But suppose we give a ration containing only one and one half pounds of digestible albuminoids and a proper or greater amount of non-albuminoids. We are now giving the cow a ration that does not contain within it an amount of albuminoids sufficient to meet the demands of nature. She is certainly now in an unnatural or abnormal condition, and we

Digitized by Google

may properly speak of such rations as abnormal anced rations. May we not expect abnormal results f feeding? We know that other abnormal conditions unnatural results.

I have frequently been asked the question, "If poorer ration, as straw without much grain, my cows milk poorer in fat, will they not?" I have answere my opinion, it depended almost wholly upon the ter the cow, it would probably remain practically uncha it might be either richer or poorer. My belief is sin that so long as a cow is fed upon a well balanced rati posed of foods agreeable to her taste, the variations i cent of fat in her milk are mainly due to other circu than the sources from which the nutrients in her r derived.

Begin with table 1, and follow the changes throug Duchess we find a small but nearly constant increa Duchess, 2d, shows a steady decrease. Duchess, fresh in milk and, as before stated, was off feed ear experiment. Princess Leto and Pilot's Lily made ar in period 2, followed by a decrease in period 3, and ar in period 4. Does the increase of one, or two tenth per cent, in period 2, and a decrease of one seven per cent in period 3, prove, or even indicate that has a tendency to cause cows to give richer milk corn meal has a tendency to produce poorer milk? more probable that these slight changes were induc unusually narrow ration followed by the change to a he ration? Again, does the decrease in Frost and Ma period 3, of four or five hundredths of one per ce that corn meal produces poor milk; or does it show spite of the radical change in the food, these two c tinued to maintain the *quality* of their milk at the ex *quantity?* To show the matter more plainly, I insert record of Maramee for periods 2 and 3.

Digitized by Google

ily record of Maramee, period 2. *Nutritive ratio,* 1 : 6.2.

ek, yield of milk...	30.38	30.38	31.69	29.63	31.44	31.56	32.00	Av'ge, 31.01
ek, yield of milk...	31.68	32.00	31.88	31.63	30.87	31.25	31.81	" 31.59
ek, per cent of fat..	3.13	3.05	2.96	2.88	3.10	3.17	3.22	" 3.07
k, per cent of fat .	3.13	3.00	3.00	3.09	3.09	3.13	3.22	" 3.08

ily record of Maramee, period 3. *Nutritive ratio,* 1 : 9.8.

ek, yield of milk...	30.63	30.31	30.50	30.06	29.57	28.44	27.31	Av'ge, 29.46
ek, yield of milk...	27.81	27.00	27.50	27.25	27.12	27.50	25.50	" 26.38
ek, per cent of fat..	3.09	3.17	2.88	2.92	2.96	2.96	2.92	" 2.99
k, per cent of fat..	3.00	3.05	3.13	3.13	3.17	3.00	3.22	" 3.10

is seen that in period 2, when the change was from mixed oat hay to mixed hay alone, that there was a constant ase in milk, but no practical change in the fat contents. e are fluctuations from day to day, but these balance each so nearly that the averages of the first and second weeks early identical.

period 3, with the substitution of corn meal for gluten cotton-seed meal, the division of the period into weeks s a different showing. We have first a falling off in tity and quality of milk, followed by a still greater loss antity and increase in fat. If we compare the last weeks e two periods, we see that the yield of milk shrank one , while in richness it increased one one hundred and h; or the shrinkage was over sixteen per cent and the ase in fat less than one per cent.

ese results are closely in accord with previous investi- ns at this station. See Bulletin No. 9, pages 12–14. In xperiments there recorded the substitution of corn meal luten gave a shrinkage of milk of 8.5 per cent, while the ge in per cent of fat was .09 of one per cent.

EFFECT ON BUTTER PRODUCT.

the close of each period, milk from groups 1, 2, and 4, from Maramee of group 3, was separated with the De l Baby Hand Separator.

e cream was cooled to 45° F., and churned on the fol- ng day, while still sweet. Analyses of both the skim-

Digitized by Google

milk and buttermilk were made and samples of butter were reserved for future examination.

The comparative hardness of the butter was determined by Prof. C. L. Parsons, by means of the apparatus described in Bulletin No. 13—that is, by recording the depth of penetration of a glass rod dropped from a given height. The softer the butter, the further the rod will penetrate. The changes in food, such data as may be of general interest as to churnability, loss of fat in skimmilk and buttermilk, and hardness of butter are given in the following table.

The character of the butter from the different groups was practically constant with the exception of hardness. In hardness there were several sharp variations. With Princess Leto and Pilot's Lily the change from a heavy grain ration resulted in a much softer butter. With Maramee the substitution of corn meal for gluten and cotton-seed meal resulted in decidedly hardening the butter. Corn meal usually produces butter of a firm texture, but cotton-seed meal has the same tendency in a greater degree and might have been expected to balance the softening influence of gluten. It would seem probable that the very wide nutritive ratio of the ration fed in period 3 should be credited with a part of this effect. With Chinchilla, Jr., and Frost, Jr., the change to oat hay resulted in a very much softer butter. Although the butters from rations containing oat hay were generally softest, it is doubtful if the whole of the variation in this instance is traceable to it.

A study of the figures given in relation to the amount of fat lost per pound of butter recovered and the pounds of milk required per pound of butter, may be of interest. They are to a certain extent an illustration of the differences between the four breeds of cows. The approximate amount of butter from each cow can be easily calculated by reference to tables 1, 2, 3, and 4. The figures show what wide variations exist between different cows and herds.

Digitized by Google

	Period.	Ration. Ensilage, mixed grain, and —	Nutritive ratio.	Separating temperature, degree, F.	Speed of separator, revolutions per minute.	Churning temperature, degree, F.	Time churning in minutes.	Per cent of fat in skimmilk.	Per cent of fat in buttermilk.	Fat lost per pound of butter recovered.	Milk required per pound of butter.	Hardness of butter, mm. of penetration.
Duchess and Duchess, 2d.	1	Mixed and oat hay	1:6	82	6,100	48-54	15	.13	.48	.037	20 22	10 5
	2	Clover	1:5.2	88	6,500	48-54	35	.13	.82	.050	23 85	8 0
	3	Mixed hay	1:6.2	90	6,500	48-55	44	.20	.50	.061	23 91	6 0
	4	Mixed and oat hay	1:6	90	6,500	48-52	25	.08	.65	.043	23 92	9.0
Princess Leto and Pilot's Lily.	1	Mixed and oat hay	1:6	77	6,100	48-58	47	.22	.26	.036	17 75	5 0
	2	Vetch hay	1:4.7	88	6,500	52-57	35	.16	.29	.027	15 21	5 5
	3	Mixed hay and corn meal	1:6.2	90	6,500	52-58	60	.20	.23	.031	16 39	5 5
	4	Mixed and oat hay	1:6	90	6,500	52-51	49	.08	.40	.030	16 89	12 0
Maramee.	1	Mixed and oat hay	1:6	74	6,100	48-54	23	.35	.53	.115	32 05	17 0
	2	Mixed hay	1:6.2	90	6,500	49-53	30	.16	1.74	.102	30 75	18.5
	3	Corn meal in place of gluten and cotton-seed	1:9.8	90	6,500	48-54	68	.23	.40	.080	30 86	12.0
	4	Mixed and oat hay	1:6	92	6,500	48-56	82	.15	.45	.080	32 97	18 0
Chinchilla, Jr., and Frost, Jr.	1	Mixed and oat hay	1:6	76	6,100	48-56	27	.39	.41	.080	24 27	8 0
	2	Oat hay	1:5.8	88	6,500	48-54	25	.16	.52	.048	20 92	20 0
	3	Clover	1:5.2	90	6,500	48-56	45	.30	.60	.077	22 37	16 0
	4	Mixed and oat hay	1:6	92	6,500	48-56	77	.15	.65	.072	25 55	16 0

Digitized by Google

Determinations of the per cent of caseine in the milk of the cows in groups 1, 2, 4, and of Maramee of group 3, were made by Mr. E. P. Stone at the close of each period, a composite sample from the milk of the last five days in each period being used for the purpose. The results appear in the last columns of tables 1, 2, 3, and 4.

No variations that can be attributed to the character of food are found. A comparison of the different cows shows that the differences in the richness of their milk is rather more marked with reference to fat than to caseine. The following table shows the percentages of fat and caseine in the milk of the different cows during period 1, and it also shows the relative proportions of fat and caseine.

PER CENT OF FAT AND CASEINE IN PERIOD 1.

	Fat.	Caseine.	
Duchess	3.91	2.90	Ratio, 1 to .74
Duchess, 2d . . .	4.03	2.64	" 1 to .66
Princess Leto . . .	5.23	3.45	" 1 to .66
Pilot's Lily . . .	5.19	3.65	" 1 to .69
Maramee . . .	3.08	2.66	" 1 to .86
Chinchilla, Jr. . .	4.32	3.17	" 1 to .73
Frost, Jr. . . .	4.02	2.96	" 1 to .74

It will be seen that low percentages of fat are accompanied with low percentages of caseine. Poor in fat means, then, poor in caseine, although in the poorest milk the amount of caseine more nearly equals the amount of fat than in the richest milk.

Digitized by Google

Scj 1636.35

NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION,
DURHAM, N. H.

BULLETIN NO. 19.

SPRAYING APPLES AND PEARS AGAINST FUNGI.

FEBRUARY, 1894.

CONCORD, N. H.:
REPUBLICAN PRESS ASSOCIATION.
1894.

Digitized by Google

Digitized by Google

SOME FUNGUS DISEASES OF PLANTS AND THEIR TREATMENT.

It is the purpose of this bulletin to call the attention of farmers to the causes of certain losses in their crops, and the treatment by which some of them may be profitably prevented. The injuries caused to crops by insects have long been known and understood; because in most cases the insects and their methods of operation could be seen with the naked eye. But there is another class of injuries, know as blights, rusts, smuts, mildews, etc., which have not been well understood, for the reason that the nature of their cause could only be made out by the aid of the microscope. These diseases have been attributed to various causes, usually some condition of the soil or the weather, but it is now known that they are due to the growth on the affected plants of minute *parasitic* plants, which as a class are called fungi (fungus is the singular, fungi the plural).

The fungi, while being as truly plants, differ in many of their characteristics from the plants on which they grow. Most of them are very small, so as to be invisible to the naked eye, except when growing in considerable quantity. They do not possess roots, stems, leaves, and flowers like ordinary plants, but consist chiefly of minute slender threads or tubes, which grow in or upon the tissues of the diseased plants, drawing nourishment from them in something the same way that the roots of an ordinary plant extend through the soil and draw nourishment from it. It

Digitized by Google

is by robbing the tissues of their host plants of food that the fungus plants produce their injuries. Upon the threads of the fungus plants there are produced in various ways little bodies called *spores*, which correspond to the seeds of higher plants, *i. e.*, they are the means of reproduction of the fungus. The spores are usually produced in immense numbers. When mature they are easily detached, and being so light are readily distributed by the wind, just as the seeds of many weeds are scattered.

The spores under proper conditions of temperature and moisture germinate, and if they chance to be upon a suitable plant, develop into a fungus similar to the one which produced them, and thus spread the disease.

These diseases do not affect all plants indifferently, but each plant has its own peculiar enemies. Certain conditions of weather affect more or less their development, a warm, moist season being especially favorable to them. Other things being equal, thrifty plants are less liable to be attacked than the opposite.

It has long been known that the injuries of insects could be largely prevented by applying to the affected plants certain poisonous substances, such as hellebore, Paris green, London purple, etc. These substances seem to have no effect upon fungus diseases; but others have been found which have proved to be very effectual in their treatment. Among these, the most valuable are copper carbonate and copper sulphate, the latter being commonly known as blue vitriol or blue stone. They are prepared in various ways, and sprayed upon vines or trees, there coming in contact with the fungus spores which are liable to be present, and killing them.

This treatment must be considered preventive rather than curative, for in many cases after the fungus has gained an entrance to the tissues of the host plant, it is out of reach of the spray and will develop in spite of it. In the preparation of fungicides the following formulas are recommended:

Digitized by Google

BORDEAUX MIXTURE.

Blue vitriol (copper sulphate),	1 lb.
Fresh lime,	1 lb.
Water,	12 gals.
or	
Blue vitriol,	4 lbs.
Fresh lime,	4 lbs.
Water,	50 gals. or 1 barrel

Dissolve the blue vitriol in several gallons of water, say one fourth the quantity to be used, or it may first be dissolved in a smaller quantity of hot water and then several gallons of cold water added. Slake the lime and make a thin whitewash, then pour this slowly into the solution of vitriol, stirring thoroughly; then add water sufficient blue to make up the required quantity. Before using the mixture it should be strained through sacking or a sieve of some kind, with about a 1-16 in. mesh, to remove the coarser particles, which are liable to clog the nozzle of the pump.

Iron vessels should not be used in preparing any of these mixtures.

SOLUTION OF COPPER CARBONATE IN AMMONIA.

Copper carbonate,	5 oz.
Ammonia (strong),	3 to 5 pints
Water,	45 gallons

Mix the copper carbonate with about a pint of water, and then add the ammonia. If the three pints are not sufficient, add more until the carbonate is all or nearly all dissolved; then add water to make up 45 gallons or a barrel.

MODIFIED EAU CELESTE.

Blue vitriol,	4 lbs.
Sal soda (sodium carbonate),	5 lbs.
Ammonia (strong),	3 pints
Water,	45 gallons

Dissolve the blue vitriol and soda separately in two or three gallons of water; mix the two solutions, stirring thoroughly; then add the ammonia, and dilute with water

Digitized by Google

to the required amount. A solution of one half the strength of the above is recommended by some.

SIMPLE SOLUTION OF BLUE VITRIOL.

Blue vitriol,	1 lb.
Water,	25 gallons

This solution may be used for spraying trees and vines before the leaves appear, but should not be used afterwards, as it is liable to burn the foliage.

It is often desirable, especially in spraying apple trees and potatoes, to combine a remedy for insects with the remedy for fungi. Paris green and London purple may be added to the Bordeaux mixture in the proportion of one fourth lb. to fifty gallons; but these substances should never be used with the other fungicides, as the combination will burn the foliage.

There will be required for applying these solutions or mixtures a force pump, provided with a nozzle which will give a very fine spray. The finer and more powerful the spray, the more effectively, economically, and quickly can the work be done. There are many different spraying pumps manufactured, which may be found advertised in agricultural papers. Where only vines and small trees are to be sprayed, what is known as the Knapsack pump, from the fact of its being carried on the back like a knapsack, will be found very useful, especially as it can be worked by one person while the other forms require one to pump and another to direct the nozzle. The smaller force pumps, such as are used for washing windows or carriages, are to be recommended only where there is a very small amount of spraying to be done. They are seldom provided with suitable nozzles.

The pump which will be found most generally useful, and which costs only a moderate sum, is a strong force pump, working with a lever handle, which can be attached to the head or side of a barrel or cask. The pump should be provided with ten or twenty feet of hose and a suitable

Digitized by Google

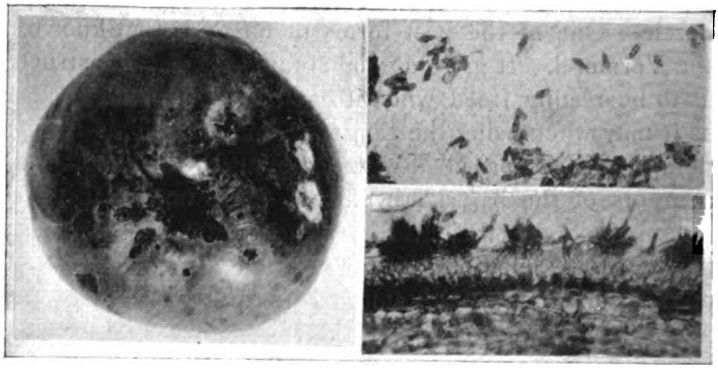
nozzle. One of the best forms of nozzle is that known as the Vermorel. It gives a good spray and is so constructed as to be readily freed when it happens to become clogged, as it may when using the Bordeaux mixture. This form of pump is usually provided with some means for keeping the contents of the barrel stirred up; but if not, or if it does not prove to be efficient, some other means will have to be employed, as the stirring is necessary in using the Bordeaux mixture or mixtures containing Paris green or London purple. The pump should be of brass, or lined with brass, as the substances used in spraying are liable to corrode iron.

The barrel, with pump attached, can be mounted on a wheelbarrow, drag, or wagon. In spraying tall trees the nozzle and hose may be attached to a light pole. Spraying pumps may be obtained through hardware dealers, or directly of the manufacturers, who will send price-lists on application. The following firms make good pumps: W. B. Douglass, Middletown, Conn.; Field Force Pump Co., Lockport, N. Y.; Nixon Nozzle and Machine Co., Dayton, Ohio. A Knapsack pump will cost about $14.00. A force pump and barrel, as described above, will cost $10 to $12.

The chemicals for making the fungicides may be obtained of any druggist.

Certain varieties of apples and pears are subject to a fungus disease which is known as Scab. It appears in the form of black or greenish black spots on the surface of the fruit and leaves. The spots are round in outline, from a sixteenth to half an inch in diameter, often running together, forming large irregular patches, and sometimes almost entirely covering the fruit, which is also frequently one-sided and more or less cracked. When examined under the microscope the spots are found to be a mass of closely interwoven fungus tissue, growing on the skin of the fruit and sending up a multitude of little stalks, on the tops of which grow elongated oval bodies—the spores or seed of the fungus plant. These, when broken off and carried to a

Digitized by Google



[On the left of the cut is shown a scabbed apple. The lower half on the right shows a perpendicular section through one of the scab spots magnified about 100 diameters. The upper half shows some of the detached spores similarly magnified.]

healthy fruit or leaf, or to a healthy part of the one on which they grew, germinate and produce a new spot. The Scab on apples and pears is considered to be produced by two different species of the same fungus, which are so nearly alike that one description answers for both.

The Scab is frequently the cause of great loss. Some varieties suffer more than others. Among apples the Fameuse or Snow apple seems to be especially liable to scab, but many other varieties suffer more or less. Among pears in this vicinity the Flemish Beauty and Sheldon are most affected, but the Seckel, Beurre d'Anjou, Lawrence, and Swan's Orange are very liable to be injured by the disease. The scabbing and cracking can be prevented to a great extent by spraying the trees several times with one of the above described fungicides.

It is probable that many spores of the scab fungus remain on the trees over winter, and are ready to infect the foliage and fruit as soon as they make their appearance in the spring; hence the first application of the fungicide should be made before the buds open. At this time the simple solution of blue vitriol may be used, but not afterwards. After the blossoms have fallen, the trees should be

Digitized by Google

sprayed again, and then once or twice more at an interval of ten days or a fortnight. For the sprayings after the first, we should at present give the preference to the Bordeaux Mixture, although the other fungicides have given good satisfaction in other places. This treatment will cost about twenty or twenty-five cents per tree per year.

Another fungus disease attacking apples and pears, especially the latter, greatly affects the appearance of the fruit, if it does not injure it otherwise. The fruit on which it grows has a dirty, sooty appearance, as though it had been exposed to the action of smoke. The fungus grows on the skin, not in well-defined spots like the Scab, but diffused over the surface. Spraying appears to be very effective against this trouble. For summary of experiments in the treatment of the above diseases, see page 10.

A third disease of the pear, which is much harder to deal with, is called the Blight. It is characterized by the blackening of the leaves and twigs, rapidly followed by their death. This may be so serious as to soon kill the whole tree. The Blight is caused by the growth in the twigs and leaves of a very minute parasitic plant, belonging to the class known as Bacteria. It is probably due to the fact that this fungus develops almost entirely inside the leaves and branches, that spraying seems to be of little use. About the only treatment that can be recommended at present is to cut off and burn the affected parts as soon as the disease makes its appearance. The twigs should be cut off at some distance below the affected spot, so as to ensure the entire removal of the germs of the disease.

The plum and cherry are affected by two serious fungus diseases, viz., the Black Knot and the Rot. The Black Knot is caused by a fungus which in some way gets inside the twigs and branches, where it develops causing the parts to swell and finally to crack open in the spring. Soon the cracked surface becomes covered with a dark greenish growth, which bears a crop of spores; later the black warty

Digitized by Google

surface develops, containing another crop of spores. Spraying has not been found to be of much use in treating this disease. The best that can be done is to cut out and destroy the diseased parts, painting the wounds to prevent the entrance of fresh spores of the fungus. As cultivated trees may be infected from the wild ones, the latter also should be taken care of. All farmers should unite in trying to stamp out this disease.

The Rot affects the fruit, and sometimes the leaves and young twigs. On the fruit it appears as a brown spot, which soon spreads, often over the whole surface of the fruit. The diseased surface soon becomes covered with many little ash-gray spots or tufts, which consist of spore-stalks bearing innumerable spores. Spraying as yet has not proven very satisfactory as a preventative of the Rot. The diseased fruit should be thoroughly removed as fast as it appears, and destroyed, and it would be well to spray the trees in the spring, before the buds open, with the simple solution of blue vitriol.

It is a rule which may be held as applying to all fungus diseases, that all diseased parts should be carefully collected and destroyed by burning.

The Blight or Rust of potatoes is a disease which can be profitably treated by spraying. A bulletin on this subject will appear later.

SUMMARY OF EXPERIMENTS IN THE TREATMENT OF THE SCABBING AND CRACKING OF APPLES AND PEARS.

The extent of these experiments has been limited by the difficulty of finding suitable trees in the vicinity of the experiment station. In 1892 a Fameuse apple-tree was sprayed with Bordeaux mixture on June 8, 16, 29, July 9, and August 5. Another tree of the same variety was left unsprayed for comparison. The apples were gathered October 7, with the following result:

Digitized by Google

	Unsprayed.	Sprayed.
Practically free from scab	29 per cent.	65 per cent.
Slightly scabbed	48 "	24 "
Badly "	23 "	11 "

The Bordeaux mixture used in this case was made according to the original formula—6 lbs. blue vitriol and 4 lbs. lime to 22 gallons of water. This has been found to be much stronger than is necessary. Also, four sprayings will usually be found sufficient.

The same season a Flemish Beauty pear tree was sprayed with Bordeaux mixture on June 1, 8, 16, 29, July 9, and August 5. Another tree was left unsprayed as a check. The pears were gathered September 21, and showed the following:

	Unsprayed.	Sprayed.
1st quality	5 per cent.	70 per cent
2d "	12 "	28 "
3d "	83 "	2 "

In this case the Bordeaux contained one pound of blue vitriol to eight gallons of water. For the last spraying, August 5, the solution of copper carbonate was used instead. Here, also, four sprayings would probably have answered.

The following experiments were made in 1893 in orchards at Durham and Dover:

In one orchard five Sheldon pear trees were sprayed May 15, just before the blossoms opened; June 1, just after the blossoms had fallen; and on June 16 and 28. On two of the trees Bordeaux mixture, of the strength of 1 lb. each blue vitriol and lime to 8 gallons of water, was used; on the others, of the strength of 1 to 12. However, owing to an oversight, the pears when gathered were not kept separate, so that the comparative effect of the two strengths could not be determined. Two trees were left unsprayed as checks.

When the pears were gathered they were examined and counted with the following result:

	Unsprayed.	Sprayed.
1st quality	3 per cent.	58 per cent.
2d "	35 "	30 "
3d "	62 "	12 "

Digitized by Google

On account of the small number of pears on these trees the above result should be taken as an indication rather than as conclusive evidence.

In another orchard on the same dates as the above the following sprayings were made:

A. Three Sheldons unsprayed as checks.

B. One Sheldon sprayed with Bordeaux mixture, containing one pound each blue vitriol and lime to 12 gallons water.

C. Two Sheldons, Bordeaux mixture 1–16.

D. Two Sheldons, Modified Eau Celeste.

E. Three Sheldons, Ammoniacal Solution Copper Carbonate.

When gathered the following was found to be the result:

	A.	B.	C.	D.	E.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1st quality . . .	29	67	76	52	32
2d " . . .	42	30	16	29	38
3d " . . .	29	3	8	19	30

Four Lawrence pear trees were sprayed with Bordeaux mixture, and one left unsprayed. The sprayings were made May 20, June 10, 21, and July 1.

The pears when gathered showed the following:

	Unsprayed.	Sprayed.
1st quality	57 per cent	55 per cent.
2d "	43 "	45 "
3d "	0 "	0 "

These figures do not show the full effect of the spraying. From the statements of the owner it was inferred that the pears were subject to the attacks of some fungus disease, but not being familiar with the Lawrence we did not know just what one. The sequel showed that there were two, one the ordinary Scab and a second fungus described on page 9. While the pears from the unsprayed tree classed as first quality were of good size and such as are frequently seen in the market, the majority of them were more or less badly disfigured by this fungus. On the unsprayed tree 88 per cent. of the pears were affected with it, while on the sprayed trees less than 1 per cent. were affected. So far as our observation goes the Scab does not seem to affect the

Digitized by Google

ıce so seriously as it does some other varieties, and w of the pears on the unsprayed tree were badly ed by it. But 63 per cent. showed more or less of it, nly 20 per cent. of the sprayed were at all scabby.

following trees which were sprayed were in a sense l, that is to say, there were no other trees of the ariety in the immediate vicinity to serve as checks.

lemish Beauty tree was sprayed May 15, June 1, 16, , with Bordeaux mixture, one pound each blue vitriol ıe to twelve gallons water. The result was,—

ty	58 per cent.
. . . . .	38 "
. . . . .	4 "

safe, we think, to say that in this region untreated h Beauty trees will not average to yield over 10 or cent. of first quality or marketable pears.

ther Flemish Beauty was sprayed June 2, 15, 21, and with Bordeaux mixture, one pound each blue vitriol ıe to sixteen gallons of water. The result was,—

ty	27 per cent.
. . . . .	36 "
. . . . .	37 "

eems probable that the less favorable result in this vas due to the fact that the spraying was begun late weaker form of the remedy was used. The owner ıowever, that this yield is better than that of previous Another tree, which was supposed to be a Flemish but which proved to be a Louise Bonne, was d on the same dates as the preceding tree with ɔniacal Solution of Copper Carbonate. The fruit when ed showed,—

ity	46 per cent.
. . . . .	51 "
. . . . .	3 "

gentleman who occupied the place says that last ıot more than 25 per cent. of the pears were of the uality, owing to the Scab.

H. H. Lamson.

Digitized by Google

Digitized by Google

CAROL SCIENCE LIBRARY

Digitized by Google

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION,
DURHAM, N. H.

BULLETIN NO. 20.

EFFECT OF FOOD ON MILK.

FEEDING WITH FATS.

MARCH, 1894.

CONCORD, N. H.:
REPUBLICAN PRESS ASSOCIATION.
1894.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

Digitized by Google

EFFECT OF FOOD ON MILK.

FEEDING WITH FATS.

BY A. H. WOOD.

In previous investigations to determine the effect of foods upon the character of the butter product,* we found that gluten meal produced a very much softer butter than did corn meal. This result was hardly to have been expected, since gluten meal is a by-product from the manufacture of glucose from corn, and it might naturally be supposed that the butters would have the same general characteristics.

The fact that the gluten meal fed was very rich in oil (containing 18 per cent.), suggested the carrying out of an experiment to determine the effect of oils upon the quantity and quality of milk and butter.

In the course of the experiment the following were fed: cotton-seed oil, corn oil, palm oil, cocoanut oil, oleo oil, and stearin.

No difficulty was experienced in getting the cows to eat these oils in connection with their grain ration, and in several instances a decided liking for them was manifested. Three cows—Duchess, Princess Leto, and Maramee—were selected for the experiment. Their previous ration had been as follows, per 1,000 pounds, live weight:

Fifty lbs. ensilage, 5 lbs. mixed hay, 5 lbs. oat hay, 5 lbs. mixed grain (equal parts of cotton seed, gluten, and middlings), furnishing 2.45 lbs. of albuminoids, and 14.71 lbs. of non-albuminoids. Nutritive ratio,—1 : 6.

The cows were fed for two weeks upon a preparatory ration, containing none of the oils to be experimented with except what corn oil would be contained in 25 pounds of ensilage. This ration, which we will call ration A, was made up as follows:

* Bulletin 13.

Digitized by Google

			Albuminoids.	Non-Albuminoids.	
Ensilage,	25	lbs.,	.37	3.70	
Clover hay,	8	"	.62	3.58	
Vetch "	4	"	.37	1.51	
Ground oats,	4	"	.40	2.33	
Middlings,	4	"	.53	2.31	N. R., 1 : 5.9
			2.29	13.43	

In period two, palm oil was added to the ration of Duchess, corn oil to that of Princess Leto, and cotton-seed oil to that of Maramee—in all cases at the rate of 12 ounces per 1,000 pounds live weight. As fats are reckoned as two and a half times as valuable as other non-albuminoids, this addition widened the nutritive ratio to 1 : 6.8. We were able to obtain but a small quantity of corn oil, and the supply gave out after feeding ten days. Princess Leto then returned to Ration A for the remaining six days of period two. At the beginning of period three we were obliged to substitute clover hay for the four pounds of vetch hay previously fed, thus slightly widening the nutritive ratio to 1 : 6.9. Duchess now received stearin, and Princess Leto had oleo oil. Maramee was given cocoanut oil, but soon went off feed and was dropped from the experiment.

In period four, Duchess was fed cotton-seed oil and Princess Leto cocoanut oil. At the close of period four both cows returned to the ration which had been fed previous to the experiment. This they received until they went to pasture, May 30.

The milk from each cow was analyzed daily, and determinations of caseine were made by Mr. E. P. Stone, from a composite sample taken from the milk of the last five days in each period. At the close of each period milk from each cow was separated, the cream held in cold storage until the next day, and churned while still sweet. Analyses of the skim milks and buttermilks were made, and samples of butter reserved for examination. The comparative hardness of the butter was determined by Prof. C. L. Parsons, as described in previous papers. Chemical investigations of the butters were carried out by Prof. F. W. Morse, chemist of the station, the results of which appear in Bulletin 16. The separation of cream from the milk was effected with a DeLaval Baby Hand Separator, at a temperature of 90° F., with the exception of the lots of July 4, when the temperature was 85° F. The following table gives all the data of general interest:

Digitized by Google

Date.	Period.	Rations.	Nutritive ratio	Average daily yield of milk,	Average per cent. of fat.	Per cent. of casein	Average amount of fat in milk per day, lbs.	Churning temperature, deg. F.	Time of churning, min.	Fat in skim milk, per cent.	Fat in buttermilk, per cent.	Hardness of butter, m. m. of penetration.
February 25 to March 2	....	.....	1:6	29.15	4.10	3.14	1.20	.....	.....	.....	.....	.....
March 3 to March 15	1	A	1:5.9	27.68	4.43	3.30	1.23	48°-50°	70	.13	1.22	15.0
March 16 to March 31	2	A + Palm oil.....	1:6.8	28.81	4.52	3.08	1.30	48°-52°	88	.09	1.13	14.0
April 1 to April 15	3	A + Stearine	1:6.9	29.19	4.41	3.01	1.29	48°-50°	68	.15	.48	13.5
April 16 to April 30	4	A + Cotton-seed oil.....	1:6.9	29.43	4.11	2.99	1.21	50°-59°	35	.13	1.04	17.0
May 1 to May 29	5	.....	1:6	32.33	4.07	3.01	1.32	52°-58°	30	.17	.69	14.0
May 29 to July 4	6	Pasture	.....	30.23	4.58	3.16	1.38	54°	13	.26	1.36	.....
PRINCESS LETO.												
February 25 to March 2	....	.....	1:6	19.37	5.12	3.22	.99	.....	.....	.....	.....	.....
March 3 to March 15	1	A	1:5.9	20.38	5.18	3.58	1.06	48°-64°	195	.08	1.13	7.5
March 16 to March 25	2	A + Corn oil.....	1:6.8	20.52	5.48	3.27	1.12	58°-64°	84	.13	1.00	9.0
March 26 to March 31	....	A	1:5.9	20.68	5.24	.....	1.08	51°-58°	100	.....	.78	7.0
April 1 to April 15	3	A + Oleo oil.....	1:6.9	21.58	5.19	3.35	1.11	50°-58°	300	.26	.48	6.5
April 16 to April 30	4	A + Cocoanut oil.....	1:6.9	20.67	5.34	3.40	1.10	50°-56°	340	.26	.87	5.7
May 1 to May 29	5	.....	1:6	22.55	4.89	3.29	1.10	52°-60°	90	.17	.34	8.0
May 30 to July 4	6	Pasture.....	.....	20.81	4.90	3.31	1.02	54°	15	.39	.78	.....
MARAMEE.												
February 25 to March 2	....	.....	1:6	23.35	3.29	2.58	.77	.....	.....	.....	.....	.....
March 3 to March 15	1	A	1:5.9	23.82	3.22	2.89	.77	48°-52°	42	.14	1.30	16.0
March 16 to March 31	2	A + Cotton-seed oil	1:6.8	24.04	3.47	2.71	.83	48°-54° 51°-58°	90 95	.17	.61	15.5
April 1 to April 12	3	A + Cocoanut oil.....	1:6.9	20.74	3.08	2.38	.64	.....	.....	.....	.87	29.0

Digitized by Google

CORNELL SCIENCE LIBRARY

With Duchess, the change to ration A resulted in a decrease of 1.47 pounds of milk per day, and an increase in fat of .33 per cent. Princess gave an increase in milk of 1.01 pounds, in fat of .06 per cent. Maramee gave an increase of .47 pounds of milk, and a decrease in fat of .07 per cent.

Duchess (Ration A): Decrease in milk, 1.47 lbs.; increase in fat, .33 per cent.

Princess Leto (Ration A): Increase in milk, 1.01 lbs.; increase in fat, .06 per cent.

Maramee (Ration A): Increase in milk, .47 lbs.; decrease in fat, .07 per cent.

In period two, the addition of the oils resulted in each case in an increase of both milk and fat, as follows:

Duchess (A+palm oil): Increase in milk, 1.13 lbs.; increase in fat, .09 per cent.

Princess Leto (A+corn oil): Increase in milk, .14 lbs.; increase in fat, .30 per cent.

Maramee (A+cotton-seed oil): Increase in milk, .22 lbs.; increase in fat, .25 per cent.

During the last six days of period two, in which Princess Leto was again on ration A, she still further increased her yield of milk .16 pounds and reduced its fat, .24 per cent.

In period three, Duchess and Princess Leto both increased in milk and decreased in fat, while Maramee decreased in both milk and fat.

Duchess (A+stearine): Increase in milk, .38 lbs.; decrease in fat, .11 per cent.

Princess Leto (A+oleo oil): Increase in milk, .90 lbs.; decrease in fat, .05 per cent.

Maramee (A+cocoanut oil): Decrease in milk, 3.40 lbs.; decrease in fat, .39 per cent.

As before stated, Maramee went off feed about the middle of this period, and was dropped from the experiment. This explains her sharp shrinkage.

In period four, Duchess again gained in milk and shrank in fat, while Princess Leto shrank in milk and gained in fat.

Digitized by Google

ness (A+cotton-seed oil): Increase in milk, .24 lbs.; decrease in fat, cent.
cess Leto (A+cocoanut oil): Decrease in milk, .91 lbs.; increase in per cent.

e return, in period five, to their regular ration was followed sharp increase in milk and a decrease in fat.

hess: Increase in milk, 2.90 lbs.; decrease in fat, .04 per cent.
cess Leto: Increase in milk, 1.88 lbs.; decrease in fat, .45 per cent.

period six, the cows were at pasture and both shrank in Duchess increased in fat, while Princess Leto remained ically constant.

hess: Decrease in milk, 2.10 lbs.; increase in fat, .51 per cent.
cess Leto: Decrease in milk, 1.74 lbs.; increase in fat, .01 per cent.

would seem that the first effects of feeding oils was to ase the fat in the milk. Princess, in period one, averaged per cent.; with the addition of corn oil her average for lays was raised to 5.48 per cent., an increase of three s of one per cent. Omitting the oil, her average for the five days fell to 5.24 per cent. Had similar results been ed with the other cows, as probably would have been the had they all returned to ration A, and the experiment ed at this point, it might have been said that it had been en that adding fat to the ration increased the fat in the milk. we notice that the sharp increase in fat was followed by a ease, until the milk again nearly reached its normal condi- In period two, with palm oil, Duchess gave milk with per cent. of fat; in period four, with cotton-seed oil, it o 4.11 per cent. We cannot say that this change was due e change in oils, for in period two, Maramee, with cotton- oil, increased the fat in her milk from 3.22 to 3.47 per

he addition of these oils to the cows' rations produced no ctionable qualities in the butter product. With respect to ness, there are two variations that should be noticed: 1. softening of the butter from Princess Leto when upon oil. The change was noticeable, not alone in the butter,

CABOT SCIENCE LIBRARY

Digitized by Google

but in its quick churning. This change seems to be an explanation of the difference in the hardness of butters from corn meal and gluten, which is a by-product of corn. Corn meal contains about 4.50 per cent. of this oil, while the gluten from which we have obtained soft butters contains about 18 per cent., or four times as much as the corn meal. 2. The softening of the butter of Duchess when upon cotton-seed oil. With Maramee upon cotton-seed oil we got very unsatisfactory results, one sample taken March 27 showing very little variation from her previous butters, while another sample, taken four days later, proved to be remarkably soft. If it prove true, on further investigation, that cotton-seed oil does soften butter, it will show that cotton-seed and its meal contains something that not only offsets the tendency of its oil, but gives to the butter product of the cows fed upon it a remarkably firm texture.

We propose at some future time to make a much more thorough study of the effects of both corn oil and cotton-seed oil, with reference to their effect upon the character of butter.

The variations in per cent. of fat in buttermilk were quite wide, and although they are given in the table I will make no comment upon them, as the very small quantities of cream churned probably caused imperfect churning.

Now, in conclusion, I think that I may say that this experiment indicates,—

That the first effect of an increase of fat in a cow's ration is to increase the per cent. of fat in her milk;

That with the continuance of such a ration, the tendency is for the milk to return to its normal condition;

That the increase in fat is not due to the oils, but to the unnatural character of the ration;

That the results in this experiment tend to confirm the conclusions expressed in previous bulletins from this station, that the composition of a cow's milk is determined by the individuality of the cow, and that although an unusual food may disturb for a time the composition of the milk, its effect is not continuous.

Digitized by Google

Sci 1636.35

NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION,
DURHAM, N. H.

BULLETIN NO. 21.

RM YARD MANURES AND ARTIFICIAL FERTILIZERS.

APRIL, 1894.

CONCORD, N. H.:
REPUBLICAN PRESS ASSOCIATION.
1894.

CARROLL SCIENCE LIBRARY

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

Digitized by Google

RIMENTS WITH MANURES AND ARTI-FICIAL FERTILIZERS.

experiments recorded in this Bulletin are in part the obtained at Hanover, N. H., previous to the removal Experiment Station to Durham, and in part results at er place.

erm *manures* applies to farm-yard manures, and in this eans the mixed manure from cows, young stock, and th the ordinary amount of absorbents,—such as straw, , etc. The term *artificial fertilizers* means either pared or *commercial* fertilizers, or chemical fertilizers are prepared or mixed on the farm.

NATURAL MANURES.

manure produced by farm animals varies considerably , according to the richness of the food, also from the animal producing it, as well as the condition in which nal is; but by far the most important factor affecting ity of manure is the manner of *collecting* and *keeping*. t one half of the value of the manure from an ox or found in the liquid excrement, hence at the outset it s necessary to adopt some plan by which this may be The common, and probably the best, plan is to use nts, which will readily take up this liquid and save it; nitrogen contained in liquid manures is easily ferment-nd when fermenting gives off ammonia, and as this represents more than *one third* of the total value of e solid and liquid excrement, it at once becomes evi-t it should be carefully managed, and it was in view of ndency to loss from fermentation that the following ents were carried on.

CABOT SCIENCE LIBRARY

Digitized by Google

(a) Manure in masses is almost sure to ferment or heat. Some manure, like that from horses and sheep, is more prone to fermentation than other kinds; but all, if left for a long time in large quantities, is sure to develop more or less heat.

(b) All manures contain soluble plant food, and the percolation of water through masses of manure is sure to dissolve out, and, if possible, carry away, this plant food.

In view of these two facts, it becomes a question whether we should allow manure to collect long enough to allow fermentation to take place; and, secondly, whether any method which allows the rains to wash piles of manure should be tolerated by the careful farmer.

The tendency of water to dissolve out the really valuable parts of manure, and carry these constituents in solution, and the further tendency of soil to sort out this material, as the water filters through the soil, and retain it, are facts which also have a bearing on the solution of the problem of how to apply manures.

We are to consider then, first, *when to apply manure;* secondly, *how to apply it;* and, thirdly, *how much to apply.*

SPRING OR FALL APPLICATION OF MANURE.

In Bulletin 6 of this station, page 5, two acres of land are reported on, one having 6 cords of manure on the surface in the fall, the other having 6 cords in the spring.

		Sound corn.	Soft corn.	Fodder.
The yield was	Fall manuring,	3,070 lbs.	754 lbs.	6,066 lbs.
	Spring "	1,690 "	1,084 "	5,271 "

In the fall of 1887 five acres of land were divided into two parts. To one part 35 loads of manure were applied on the surface; the following spring an equal amount was applied to the other half, and the whole planted to ensilage. The yield was not large, as several varieties of corn were planted, three of which did not prove well suited to the climate.

The fall manured half yielded	58,530 lbs.
The spring " "	57,605 "

The difference here is not great, and can hardly be said to give positive evidence for or against either method.

Digitized by Google

In the fall of 1888 two half acres of land were taken and plowed at the same time. August 20 to one of these was applied, after plowing, 3½ cords of manure, or 10 common cart loads. The other was left until spring, May 20, 1889, and had applied to it 3½ cords of manure. Each half acre received the same treatment and seed, and they were harvested at the same time, with the following results:

Fall manured (spread on surface in Aug.), yield of ensilage per acre, 16.48 tons.
Spring " " " May), " " " 11.72 "

Cuts Nos. 7 and 12 show ten average stalks bunched from each lot. No. 7 gives the fall manured, and No. 12 the spring manured.

Another pair of half-acre plots, where twice as many cords of manure were used, namely, 7 cords or 20 cart loads, gave the following results:

Fall manured (plowed in), cut No. 6, yielded . 23.17 tons.
Spring " " 2, " . 24.50 "

Here we have an experiment where the spring-applied manure gave best results. The plowing in of fall-applied manured on sod land is not to be recommended, and the results above recorded are no more than might have been expected, since it gave no chance for frost and rain to pulverize and distribute the manure.

HOW SHALL WE APPLY MANURE?

There was a time when it was regarded as settled that the losses from manure were through the air, that is, that the escape of ammonia was the great thing to be guarded against, and, indeed, under the then prevailing custom of allowing manures to heat,—either in piles in the yard, or, worse still, in the large heaps that were so often and are now occasionally seen where the manure has been drawn from the barn to the field, to be stored unprotected until the season for planting—this was true. Here the most favorable conditions possible for fermentation, and the attendant formation of ammonia compounds from the liquid part of the manure, are to be found, and here it is that the manure is really wasted in the air; but, aside from this inexcusable

Digitized by Google

method, the management of manure can hardly be planned so that the loss will be through the air, but rather will it result from the downward passage of soil waters. The drainage water from our fields carries fertility away, not rapidly, it is true, but appreciably, and it is the brook that wanders through our fields, and not the winds that blow over them, that rob our manured and unmanured fields of their fertility. With this view of the case, we should so place our farm-yard manure that it shall have just as much soil as possible to filter through.

Rain falling on a field, whether the field is level or considerably sloping, tends first of all to enter the soil, just as water falling on a sponge is absorbed, and the filtering away of this water causes it to flow along through the soil, not over its surface. There are exceptions; a field may be so steep that a heavy rain-fall will rush down its surface and mechanically carry away soil and manure, or the land may be so full of water that rain-water does not freely filter through it, but even then the surface water is bound to crowd out that already in the soil; so that the exceptions, while existing, are not to be considered as of more importance than the general run of cases.

Surface manuring is the logical result of a study of the facts relating to fertilizing in general, but by surface manuring I do not mean that the manure should be allowed to remain *on* the very top of the soil, but rather that it should be mixed with the top two or three inches of soil, and the more intimately it is mixed the better. And right here is where *fall surface* manuring derives its chief advantage.

I have repeatedly seen as high as forty loads of coarse green manure spread on the surface of an acre of land in the fall. To have harrowed this quantity in so that little or no manure should have been left in sight, would have been an impossibility with any form of harrow that we now have; and yet after the fall rains, the winter snows and frosts, and the spring rains had worked on that manure, an ordinary harrowing would completely incorporate it into the soil: in fact, the elements had themselves mixed the plant food with the soil, and the manure had become pulverized and as fine as compost, and with none or very little of the loss that results from rotting

Digitized by Google

or composting as ordinarily practised. Returning now to our experiments, I will quote from Bulletin 6, page 5, New Hampshire Experiment Station,—

	Sound corn.	Soft corn.	Fodder.
One acre, manure plowed in, fall applied,	2,690	935	5,555
" " on surface "	3,070	754	6,066

From our 1890 experiments,—

	Manure per acre.	Yield per acre.
Surface manured, cut 5 .	14 cords manure .	24.70 tons ensilage.
Plowed in, " 6 .	14 " .	23.17 "
Surface manured, " 7 .	7 " .	16.48 "
Plowed in, " 8, .	7 " .	16.13 "

These experiments do not show as marked differences as are often obtained, for the reason that in most cases an excessive amount of manure was used, far more than the crop could utilize.

HOW MUCH MANURE CAN WE USE?

No precise answer can possibly be given to this question, for the limit is set by the kind of crop and the nearness to market.

There is an amount of manure or fertilizer that can be used to greatest profit; then we may increase this amount and get increased crops, but the value of the increase is not in proportion to the cost of the additional manure; or we may use less, but not to as good advantage. In general the greater the market value of the crop, the greater the amount of manure that can be profitably used, and hence we cannot lay down any general rule that will apply equally to the general and special farmer.

There is another difficulty in the way of even experimentally determining how much fertilizer or manure can profitably be used, and that is the uncertainty as to the value of the manure left in the soil after the first crop is taken off. In the experiments above given, two widely varying amounts of manure were used. One, 7 cords or 20 common loads per acre, is about what our best farmers use in mixed farming; the other, 14 cords or 40 loads, represents very high manuring, so far as the common lines of farming are concerned. Take the half-acre plots represented by cuts 6 and 8: the former had $42 worth of

Digitized by Google

manure, while the latter had only $21 (this is at the comparatively low price of $3 per cord); the investment of $21 gave a gain over no manure (plot 9) of 11.44 tons of ensilage, or the cost of manure per ton of ensilage for the first 20 loads was $1.83. Now when we apply an additional 20 loads to the same land, we get as the increase due to the last amount of manure, the difference between the yield of plot 6 (23.17) and plot 8 (16.13), which is almost exactly 7 tons, or a ton for $3 worth of manure. Now, so far as this evidence goes, it is plain that 20 loads was profitable, while the additional 20 was not.

But the question comes up, How about the residue left in the soil in these two plots? This question cannot be answered, for many reasons. First, we know very little of the availability of the plant food in the manure; second, we know next to nothing of the amount lost in the drainage water; third, we have no knowledge as to the condition of the plant food that is thus left in the soil. Without doubt some portion of it is rendered insoluble by the action of the soil, thus making it of no more value than the unavailable plant food which most soils contain in considerable quantities.

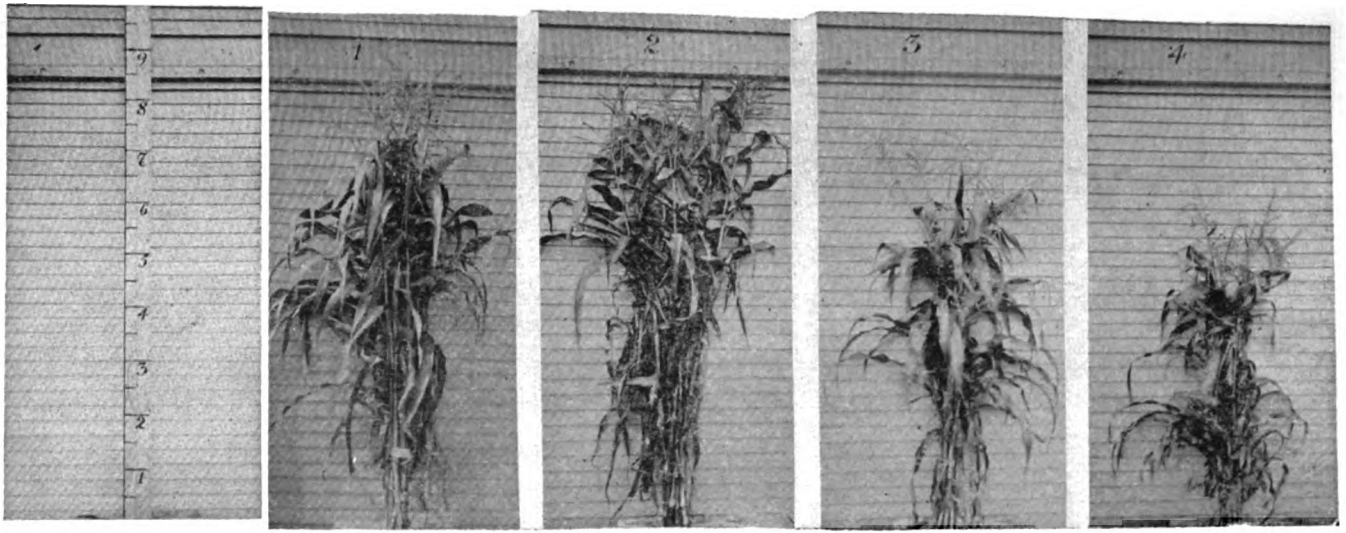
In general, I do not believe that more than from 15 to 20 loads (5 to 7 cords) of manure can be advantageously used on our field crops, like corn, oats, barley, and grass; and I do not believe that 40 loads of manure (14 cords) can be applied to two acres with more profit than to one acre.

SUBSTITUTES FOR FARM-YARD MANURE.

The subject of chemical fertilizers has been carefully studied by this station, and the results can be found in Bulletins 5, 6, 10, and 12; but as new results are year by year being added, a short statement will not be out of place in this bulletin.

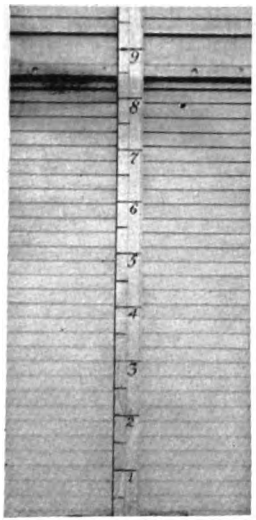
The results of all our work show, without exception, that New Hampshire soils are more in need of potash than any other element of plant food, and consequently, that we may so compound our fertilizers that better results shall follow their use than is possible with the average fertilizer found in our markets, and this the farmer is enabled to do by buying his

Digitized by Google



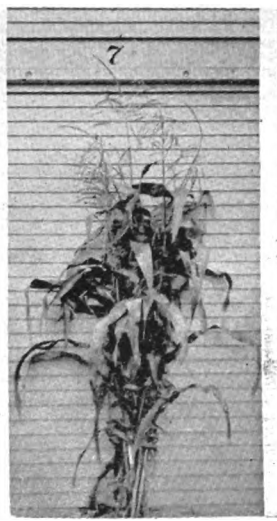
Chemicals.	Spring manured.	Manured on snow.	Manured on snow.
D. B. B., 404 lbs.,	Plowed in 14 cords per acre,	Feb. 15, 1889, 14 cords per acre,	Feb. 11, 1889, 7 cords per acre,
M. P., 122 1-2 lbs.,	24.5 tons ensilage.	16.11 tons ensilage.	10.18 tons ensilage per acre.
S. A., 86 lbs.,	Cost of fertilizer, $24.50 per half acre.	Cost of fertilizer, $24.50 per half acre.	Cost of fertilizer, $12.25 per half acre.
1,986 tons ensilage.			
Cost of fertilizer, $12.25 per half acre.			

Digitized by Google

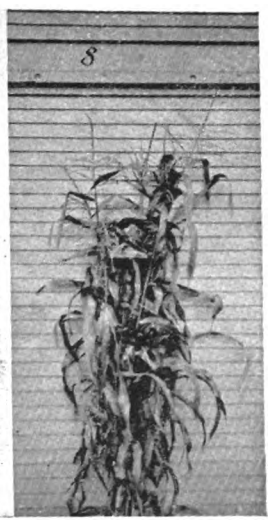


Fall manured.
Surface,
14 cords per acre,
24.70 tons ensilage.
Cost of fertilizer, $24.50.

Fall manured.
Plowed in,
14 cords per acre,
23.17 tons ensilage.
Cost of fertilizer, $24.50.

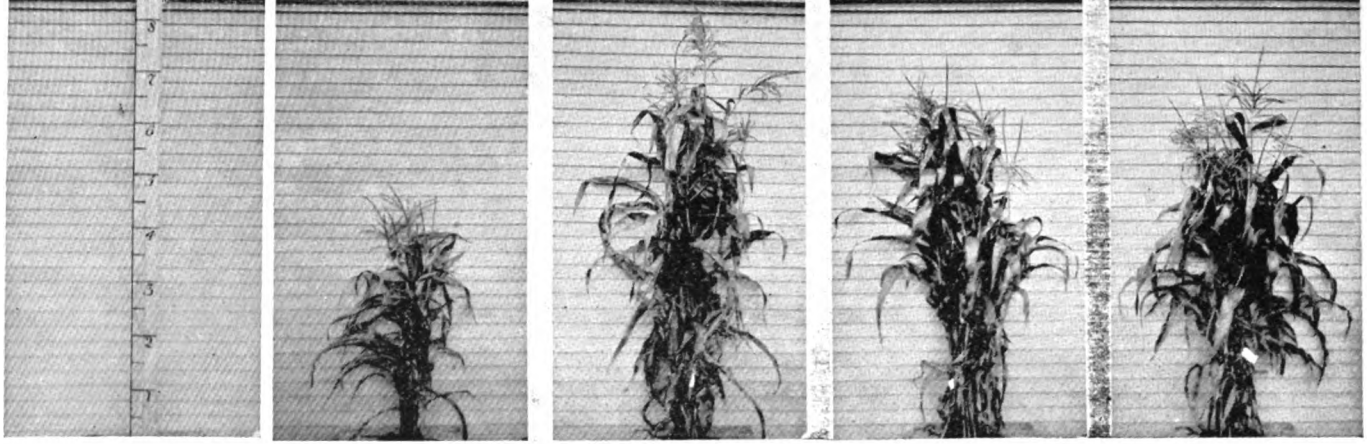


Fall surface-manured.
7 cords per acre,
16.48 tons ensilage.
Cost of fertilizer, $12.25.



Fall manured.
Plowed in,
7 cords per acre,
16.13 tons ensilage.
Cost of fertilizer, $12.25.

Digitized by Google



No manure or chemicals.
4.69 tons ensilage.

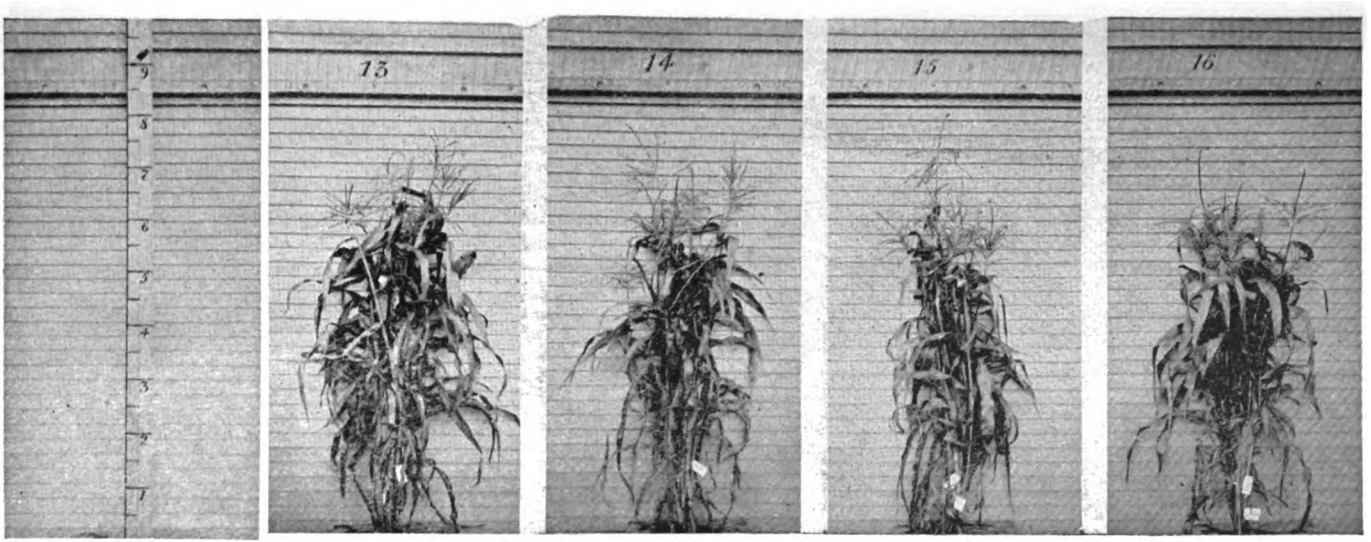
Leached ashes.
244 bushels,
16.88 tons ensilage.
Cost of fertilizer, $12.25.

Whole ashes.
98 bushels,
13.6 tons ensilage.
Cost of fertilizer, $12.25.

Spring surface manured.
7 cords per acre,
11.72 tons ensilage.
Cost of fertilizer, $12.25.

Digitized by Google

CABOT SCIENCE LIBRARY



Bowker's Hill and Drill.
680 lbs. per acre,
16.93 tons ensilage.
Cost of fertilizer, $12.25.

Chemicals.
D. B. B., 404 lbs.,
M. P., 122½ lbs.,
S. A., 86 lbs.,
16.01 tons ensilage.
Cost of fertilizer, $12.25.

Digitized by Google

e fertilizing chemicals and mixing as his soil and crops ire.

ny farmer in this state may, if he will, purchase these nicals of the wholesale dealers or fertilizer manufacturers, he is then in position to adapt his fertilizers to the crops soil he is dealing with.

compilation of all our results thus far obtained gives us ollowing table, in which one may see at a glance the rela- profit resulting from the use of chemicals and the best ared fertilizers:

Hanover farm $1 invested in prepared fertilizers gave increased crop, l at $1.80.

Hanover farm $1 invested in chemical fertilizers gave increased crop, l at **$2.80.**

ten New Hampshire farms, coöperative test, $1 invested in prepared zers, on corn, gave increased crop, valued at $0.74.

ten New Hampshire farms, coöperative test, $1 invested in chemical zers, on corn, gave increased crop, valued at **$1.71.**

ten New Hampshire farms, coöperative test, $1 invested in prepared zers, on sweet corn, gave increased crop, valued at $2.91.

ten New Hampshire farms, coöperative test, $1 invested in chemical zers, on sweet corn, gave increased crop, valued at **$3.03.**

ten New Hampshire farms, coöperative test, $1 invested in prepared zers, on potatoes, gave increased crop, valued at $2.07.

ten New Hampshire farms, coöperative test, $1 invested in chemical zers, on potatoes, gave increased crop, valued at **$4.20.**

ten New Hampshire farms, coöperative test, $1 invested in prepared zers, on potatoes, gave increased crop, valued at $4.20.

ten New Hampshire farms, coöperative test, $1 invested in chemical zers, on potatoes, gave increased crop, valued at **$6.05.**

ese results represent more than 500 individual tests, it cannot be that the results thus obtained are acci- l: they rest on some law, and from a study of the condi- of the experiments we are brought to the conclusion that prepared goods are deficient in potash. The following shows the per cents. of nitrogen, phosphoric acid, and sh in the combinations of chemicals that in actual practice proved best:

	Nitrogen per cent.	Phos. acid per cent.	Potash per cent.
esults on plots at Hanover came from mixtures			
aining	2.5	5.75	25.0

CABOT SCIENCE LIBRARY

Digitized by Google

COÖPERATIVE SERIES.

	Nitrogen per cent.	Phos. acid per cent.	Potash per cent.
Best results on seven New Hampshire farms (husked corn)	4.7	9.0	10.7
Best results on seven New Hampshire farms (fodder)	2.3	9.5	11.9
Best results on potatoes	2.3	11.6	7.1
Best results on sweet corn	2.1	10.8	11.0
Best results on ensilage	.0	4.0	24.0
Best results on potatoes (2d series)	2.8	9.7	12.4
Average composition of mixtures of chemicals that have produced best results	2.4	8.6	14.6
Average composition of fertilizers sold in the state	3.0	12.0	3.0

RELATIVE EFFICIENCY OF CHEMICALS AND FARM-YARD MANURES.

Can chemical manures compete with farm-yard manures? Will they hold out?—These are questions that are asked hundreds of times every year by careful farmers.

The experiment begun at Hanover in 1885, and reported on at times as the work progressed, is now completed, the full rotation having been accomplished the year before the station was moved from that town.

Two acres of land, from a field of six acres, were selected for this experiment. The land had produced hay for three years previous to 1885; oats and sugar-beets had preceded the hay.

The third acre had 13 loads of manure plowed in and 9 loads harrowed in, or in cords this would be 5.6 cords plowed in and 3.8 cords on surface, or 9.4 cords in all, which would sell, as it lay under the stables, for $33. This manure was from fattening steers, well fed with hay, straw, cotton seed, and corn meal. The fourth acre had yearly applications of chemical fertilizers, mixed as follows:

Dissolved bone-black	346 lbs.
Muriate of potash	150 "
Sulphate of ammonia	55 "

The average cost of this mixture has been $11, and as there have been three applications since 1885, it follows that each acre has received $33 worth of fertilizer; the third having

Digitized by Google

orth of manure, and the fourth $33 worth of chemicals. irst year the crop was corn, the second year corn, the oats, and the fourth, fifth, and sixth, grass.

following table shows the yield of each acre for each and also the value of the crop, assuming 80 pounds of s harvested to be worth 60 cents, 34 pounds of soft corn nts, and fodder 30 cents per hundred, oats 50 cents per l, straw 30 cents per hundred, and hay $10 per ton:

	Third acre,—manure.		Fourth acre,—chemicals.		Total yield with manure.	Total yield with chemicals.
	1885.	1886.	1885.	1886.		
Sound*.....	112 bu.	83⅓ bu.	97 bu.	82⅔ bu.	195⅓ bu.	179⅔ bu.
Soft.....	16½ bu.	27 bu.	15 bu.	24 bu.	43½ bu.	39 bu.
Fodder.....	4,835 lbs.	4,435 lbs.	5,352 lbs.	4,927 lbs.	9,270 lbs.	10,279 lbs.
Value.....	$49.75	$41.12	$46.65	$42.00	$90.87	$88.65
	1887.					
Grain †.....	43 bu.		47½ bu.			
Straw	4,535 lbs.		5,267 lbs.			
Value	$35.10		$39.55		$35.10	$39.55
	1888.					
Yield.....	5,880 lbs.		6,202 lbs.			
Value	$29.40		$31.01		$29.40	$31.01
	1889.					
Yield.....	4,200 lbs.		4,800 lbs.			
Value	$21.00		$24.00		$21.00	$24.00
	1890.					
Yield.....	3,700 lbs.		2,800 lbs.			
Value	$18.50		$19.00.		$18.53	$19.00
al crop for six years					$194.87	$202.21
of value produced by chemicals.....					$7.34	

* Sound corn, 40 lbs. per bushel; soft corn, 34 lbs. per bushel.
† Oats, 32 lbs. per bushel.

CABOT SCIENCE LIBRARY

Digitized by Google

Plots on which no manure or chemicals were used for the same six years, gave us crops valued at $128.77, so that we have a gain of crops on the manured acre valued at $66.10, and this is the result of investing $33. On the acre fertilized with chemicals the excess is valued at $73.44.

This experiment I regard as a safe one for farmers to study, as it was on a large scale, and under the most favorable circumstances so far as the uniformity of soil and treatment were concerned.

In the series of experiments represented by the cuts in this bulletin made in 1889–'90, we have a comparison of the efficiency of chemicals, prepared fertilizers, and manure, on land which had been fertilized with ashes either in 1879 or 1880 and had since been in grass.

PREPARED FERTILIZERS, CHEMICALS, AND ASHES COMPARED.

	Cost.	Yield.
Plot 1 had the following chemicals { dissolved bone-black, 404 lbs., muriate of potash, 122½ lbs., sulphate of ammonia, 86 lbs., }	$12.25	19.85 tons.
* Plot 14, the same as plot 1	12.25	16.01 "
Plot 13 had 680 lbs. of Bowker's Hill and Drill Phosphate	12.25	16.93 "
Plot 10 had 244 bushels of leached ashes . . .	12.25	16.88 "
Plot 11 had 98 bushels of whole ashes	12.25	13.60 "

The amount and cost of the fertilizer above is per *half* acre, but the yield is computed per acre, as we are more accustomed to think of the amount we produce per acre.

MANURE AND ARTIFICIAL FERTILIZERS.

Plots 10–14 form a series which may be studied by themselves, and as the yield of 10, 11, 13, and 14 do not vary greatly, except 11, we will average them and compare them with No. 12, which was spring manured.

Fertilized with.	Cost per acre.	Tons.
Plot 10, leached ashes, " 11, whole ashes, " 13, Bowker's H. and D. Phosphate, " 14, chemicals,	$12.25	average yield, 15.85
" 12, 3½ cords of manure,	12.25	yield, 11.72
Gain in favor of artifical fertilizer,		4.13

* Plots 10 to 14 had some six or eight years previous to this experiment been fertilized with ashes.

Digitized by Google

is, however, the gain over manure spring applied. If we lot 7, where $12.25 worth of manure was fall applied, a yield of 16.48 tons, a gain of 0.63 tons in favor of e.

take plots 1, 4, 7, and 8, another series that may be com- because the fertilizer used on each represents the same

	Cost of fertilizer per half acre.	Yield per acre.
manured Feb. 11, 3½ cords per half acre,	$12.25	10.18 tons.
" fall, " " "	12.25	16.48 "
" " " " "	12.25	16.13 "
Average		14.26 "
bone-black, 404 lbs. per half acre, muriate of potash, 122½ lbs. " sulphate of ammonia, 86 lbs. "	12.25	19.85 "
n resulting from chemicals instead of manure . .		5.59 "

series of experiments carried on at Durham, under the ision of Mr. D. E. Stone, the following results were ed:

	Cost per half acre.	Yield per acre.
one half acre), 5 cords manure,	$17.50	15.08 tons.
" " 10 "	35.00	16.32 "
" " chemicals { dis. b. black, 162 lbs., mur. of pot., 50 " sulp. of am., 38 " }	5.00	13.56 "
" " Stockbridge manure, 250 lbs.,	5.00	8.13 "
" " Bowker's H. and D., 250 lbs.,	4.50	8.48 "
no fertilizer of any kind		5.46 "

his series we see that the comparatively small amount of er used on plot 3, costing only $5, gave a very credit- ield, even alongside of $17.50 worth of manure; and 10 per acre gave an increased crop of 8.10 tons, or a ton st of $1.23, but this is on the assumption that all of the cals were used up last year, which will not prove to be se.

CABOT SCIENCE LIBRARY

Digitized by Google

CHEMICAL FERTILIZERS—HOW TO MIX AND USE.

WHAT THE CHEMICALS ARE AND WHAT THEY CONTAIN AND WEIGH.

					Weight per ¼ bu.
Dissolved bone-black contains	16	per cent.	soluble phosphoric acid,		30 lbs.
Muriate of potash	" 50	"	actual potash,		34 "
Sulphate of ammonia	" 20	"	nitrogeh,		31 "
Nitrate of soda	" 15	"	nitrogen,		44 "

STANDARD COMBINATIONS.

No. I. *For Corn.*	lbs.	No. 4. *For Ensilage.*	lbs.
Dissolved bone-black	325	Dissolved bone-black	250
Muriate of potash	100	Muriate of potash	200
Sulphate of ammonia	75	Sulphate of ammonia	50
	500		500

V. *For Oats.* (Or use No. 1.)		No. VII. *For Hay.*	
Dissolved bone-black	325	Dissolved bone-black	225
Muriate of potash	125	Muriate of potash	250
Sulphate of ammonia	50	Nitrate of soda	25
	500		500

IX. *For Potatoes.* (Following a manured crop.)		X. *For Potatoes.* (On poor ground.)	
Dissolved bone-black	340	Dissolved bone-black	300
Muriate of potash	160	Muriate of potash	150
	500	Sulphate of ammonia	50
			500

These chemicals are all dry, harmless substances, as easily mixed as corn meal, shorts, and middlings. The combinations are vastly superior to the prepared fertilizers on the market,

Digitized by Google

because they are entirely soluble and contain a *high t. of potash.*

amounts are for one acre where no manure is used, and *y case* on *planted* crops use either 300 or 350 pounds of ture broadcast, putting only from 150 to 200 in the hill , and *do not let it come in contact with the seed.*

cost, on an average, about as follows:

olved bone-black	$25–$30 per ton.
iate of potash	42– 45 "
hate of ammonia	78– 80 "

y be bought of any fertilizer manufacturer.

CONCLUSIONS.

ure applied in the fall to the surface, either of plowed s land, will, by the action of frost and rain, become so ghly pulverized and distributed through the soil that it ore quickly, and is in better condition for plants to as-e, than the same manure would be if applied in the

loss from evaporation and drainage (unless the surface steep) will probably be much less than the loss result-n fermentation if the manure is allowed to accumulate rs or the washing if left in open yards.

nost soils, and for most crops, surface application is bet-plowing in, and especially if manure is applied in the t in any case, except for manure that is so coarse that it be mixed with the soil by cultivation, it is a safe rule to e manure as near the surface as possible, and to have it oughly mixed with the seed-bed as can be done. This with it the necessity of using only such bedding and nts as are of themselves fine or easily pulverized.

our common field crops—corn, oats, rye, barley, pota-c.—it is not profitable to use more than from 15 to 20 ds (5–7 cords) of manure per acre.

n average, on New Hampshire soils and with general $1.00 invested in the best prepared fertilizers has given ease of crop valued at $2 34, while $1.00 invested in emicals—dissolved bone-black, muriate of potash, and

CABOT SCIENCE LIBRARY

Digitized by Google

sulphate of ammonia—has given an increase valued at $3.56—a difference of $1.22 in favor of, and due entirely to, the substitution of chemicals for prepared fertilizers, at equal cost.

This difference is due chiefly to the wrong properties of plant food in the prepared fertilizers, and more to the deficiency of potash than any other cause.

Prepared fertilizer gives	phosphoric acid	12.0	per cent.
	potash	**3.0**	"
	nitrogen	3.0	"
While the chemicals that give best result contain	phosphoric acid	8.6	"
	potash	**14.6**	"
	nitrogen	2.4	"

Chemicals properly mixed and used can and do give as good returns as farm-yard manure, and oftentimes better, and this in a six years rotation.

Leached ashes gave better results per dollar invested than whole ashes.

G. H. WHITCHER,
Director.

Digitized by Google

Files

Sci 1636.35

HARVARD COLLEGE LIBRARY

NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION,
DURHAM, N. H.

BULLETIN NO. 22.

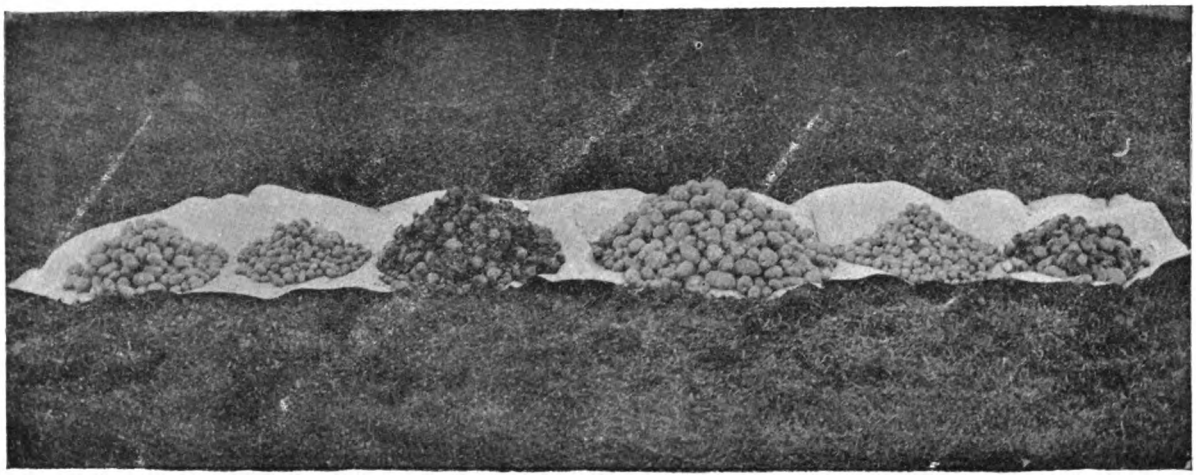
EVENTION OF POTATO BLIGHT.

MAY, 1894.

N. H. COLLEGE OF AGRICULTURE AND
THE MECHANIC ARTS
DURHAM, N. H.

CABOT SCIENCE LIBRARY

Digitized by Google



UNSPRAYED.
Merchantable—30 lbs. Small—17 lbs. Rotten—61 lbs.

SPRAYED WITH BORDEAUX MIXTURE.
Merchantable—103 lbs. Small—30 lbs. Rotten—20 lbs.

FIG. 2.

Digitized by Google

POTATO BLIGHT.

The potato crop is liable to serious losses from two sources, which losses are to a great extent preventable. These two sources of loss are the Colorado beetle, or potato bug, and the *blight* or *rust*. Every farmer knows how to deal with the potato bug. Paris green is the sovereign remedy, but it is only within a comparatively few years that a successful treatment has been found for the *blight*. It seems now, however, that an effective remedy has been found in the Bordeaux mixture.

The blight is caused by the growth in the potato vines of minute parasitic plants, known as fungi. There are two distinct species of fungi which produce the blight in potatoes,—one, known botanically as *Macrosporium solani*, causes what is now known as the early blight, the other, *Phytophthora infestans*, causes the late blight which has been the most common and destructive. Blight, rust, and rot are the various names by which it has been called. This disease seems to have been especially prevalent during the last few years, doubtless owing to the peculiar conditions presented by the weather, a warm and moist season being most favorable to its development.

It usually makes its first appearance during the month of August when the vines of the later varieties are in full growth. Early varieties often escape its attacks altogether. The leaves are the first to show its effects. They become more or less discolored, then begin at the edge to turn brown and curl up, or, if the weather be very damp, to rot. If a leaf which is only partly dead is closely examined there will be seen on the under surface, especially along either side of the line separating the dead portion from the living, a very fine white fuzz; this consists of the spore stalks of the fungus which is growing within the tissues of the leaf and which constitutes the sole cause of the disease. If a portion of the leaf thus affected be placed under

Digitized by Google

a suitable power of the microscope, the fine white branching stalks may be plainly seen growing out of the breathing pores or stomata in the epidermis, sometimes one and sometimes several growing from a single opening; on the sides and tips of their branches will be seen little white egg-shaped bodies; these are the spores or seed of the fungus causing the blight. If the interior of a leaf be examined there will be found running in all directions among the cells, especially those of the under side of the leaf, fine white threads which are the mycelium or body of the fungous plant. These threads absorb from the cells among which they run the nutriment which has been elaborated for the use of the potato itself, and cause them to die and shrivel up or decay. The spores as soon as they are mature are very readily broken off from their stalks, and being so light are easily borne by the wind to healthy vines where they germinate in any moisture they may find upon the leaves or stems and make their way through the skin or epidermis into the succulent tissues beneath, where the threads develop and in their turn send out a crop of spores which help to spread the disease.

If the weather is sufficiently warm and damp this development and spread is very rapid, so that a large field of apparently healthy vines may be entirely killed in a very few days. If this destruction of the tops occurs early, the tubers cannot mature and the yield will be a light one and of inferior quality; moreover, the fungus is not confined to the tops but makes its way into the tubers also. The potatoes thus attacked are very likely to decay, and great loss occurs, not only before they are dug but even after they are stored in the cellar, if the conditions there should be favorable. The threads of the fungus live over winter in the tubers which, if used for seed, serve to start the disease again the following summer.

Figure 1 represents a magnified section of a potato leaf affected with the blight. The leaf like all parts of the plant is made up of cells of various sizes and shapes. The upper and lower surfaces are covered by single layers of cells called *epidermis* shown at *a* and *d*. The upper side of the leaf consists of elongated cells arranged perpendicularly to the surface and closely packed

Digitized by Google

together *b*; the lower side *c* consists of irregular cells, loosely packed, having air spaces between them. Communicating with the air spaces are little openings in the epidermis, called *breathing pores* or *stomata*, one of which is shown at *e*. In the left half of the section the cells are represented filled with the *chlorophyll bodies* which contain the green coloring matter. Running among the cells are seen the threads or *mycelium* of the fungus which causes the blight; and growing from the breathing pores the branching *spore stalks* bearing the *spores*.

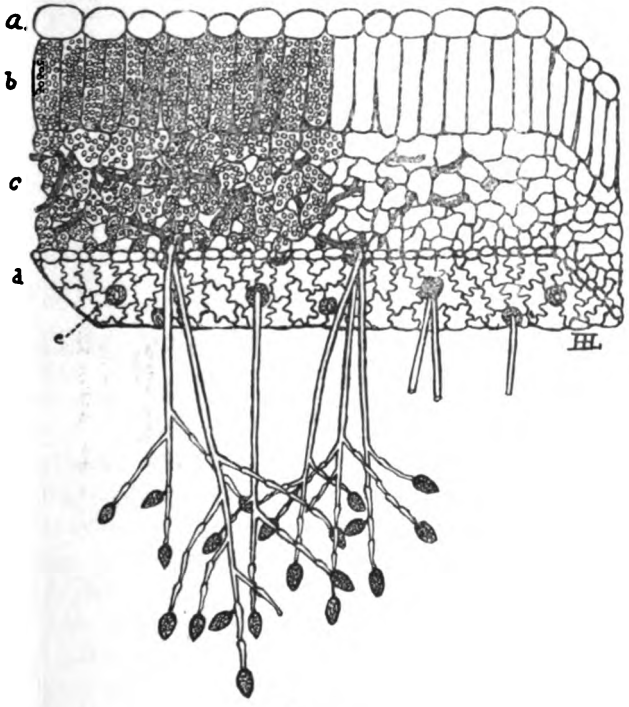


FIG. 1.

Treatment.—If it can be avoided, potatoes which are known to be diseased or which have been grown in a field attacked by the blight should not be used for seed. However, a remedy has been found which if used in season seems to be very efficient in checking or preventing the disease. This remedy is the Bordeaux

Digitized by Google

mixture, which, when applied to the vines, destroys the vitality of the spores with which it comes in contact and thus prevents the infection of healthy plants. It should be applied, if possible, before the disease makes its appearance, at least by the last of July, and the applications should be repeated at intervals of ten to fourteen days, and oftener if the mixture is washed off by rains, until the tubers have matured. Usually three applications will be sufficient but a fourth may sometimes be required.

In experiments made in the summer of 1892, the vines on the sprayed plots remained green from one to four weeks longer than those on the unsprayed plots.

In one case the yield of merchantable potatoes from the sprayed plot was about one third greater than that from a similar unsprayed plot, while on two other sprayed plots the yield was one half greater than on the unsprayed plot.

In another case, in a different field, a small sprayed plot yielded three times as many merchantable potatoes as the corresponding unsprayed plot, while the weight of rotten potatoes on the unsprayed plot was three times as great as on the sprayed plot.

A photograph of the potatoes from these two plots is reproduced in Fig. 2.

EARLY BLIGHT.

The early blight (*Macrosporium solani*) has come to be recognized as a serious disease of the potato only within the last two or three years. It was first noticed at this station in the summer of 1892. As its name indicates, it makes its appearance earlier than the ordinary blight—by the middle of July or earlier. It first appears, as sharply-defined, rather irregular, dark brown or blackish spots on the leaves. The surface of the spots is usually marked with minute wrinkles, which take roughly the form of numerous circles with a common centre; this has been called the "target marking," from its resemblance to the concentric rings of a target. The spots increase gradually in number and size till the whole leaf is destroyed.

The fungus producing this disease differs considerably in the details of its structure from the late blight, but

Digitized by Google

like it, consists of mycelial threads which grow in the tissues of the leaf and send out spore-bearing stalks on the surface. The early blight may be distinguished from the late blight by its characteristic spots, by the absence of the mould-like fuzz of the latter, by its earlier appearance and slower growth, and from the fact that it does not affect the tubers. Both diseases may be present in a field at the same time.

Our experiments have not yet definitely decided the question whether the Bordeaux mixture is as effective a remedy for the early blight as for the late, but the indications are favorable. Our experiments last summer were planned for the ordinary blight, but that did not make its appearance in this vicinity and it was rather late when our attention was directed to the new disease. Several plots were sprayed about the middle of August, and while the vines were finally killed, those which were sprayed resisted the disease about two weeks longer than the unsprayed.

One of the sprayed plots yielded twenty bushels per acre more than a similar unsprayed plot, while in another field a small sprayed plot yielded nearly double the weight of merchantable potatoes that the unsprayed plot beside it did. In treating the early blight the spraying should be commenced by the middle of July, or earlier, if signs of the disease make their appearance.

BORDEAUX MIXTURE.

Blue vitriol (copper sulphate)	1 lb.
Fresh lime	1 lb.
Water	10 gals.
or	
Blue vitriol	5 lbs.
Fresh lime	5 lbs.
Water	50 gals. or 1 barrel.

Dissolve the blue vitriol in several gallons of water, say one fourth the quantity to be used, or it may first be dissolved in a smaller quantity of hot water and then several gallons of cold water added. Slake the lime and make a thin whitewash, then pour this slowly into the solution of blue vitriol, stirring

Digitized by Google

thoroughly; then add water sufficient to make up the required quantity. Before using the mixture it should be strained through sacking or a sieve of some kind, with about a 1-16 inch mesh, to remove the coarser particles, which are liable to clog the nozzle of the pump. While spraying, the mixture should be kept thoroughly stirred up.

Iron vessels should not be used in preparing this mixture.

This formula is one fourth stronger than that recommended for spraying fruit trees.

For destroying potato bugs, Paris Green may be added to the Bordeaux mixture in the proportion of one half pound to fifty gallons.

The Bordeaux mixture may be applied to the potato vines with an ordinary watering pot, but one of the forms of spraying pump described in Bulletin No. 19 is much to be preferred. For small fields, and where the work is to be done by one man, the Knapsack pump is a good form; but for general use one of the force pumps which can be attached to a barrel will be found more satisfactory. The pump should be provided with a nozzle which will give a fine spray, the form known as the Vermorel is one of the best. Spraying pumps should be brass lined. They may be obtained through any hardware dealer or direct from the manufacturers. W. & B. Douglas, Middletown, Conn.; George Tyler & Co., 43 South Market st., Boston; Field Force Pump Co., Lockport, N. Y.; Nixon Nozzle and Machine Co., Dayton, Ohio, are reliable firms. Blue vitriol may be obtained from any druggist, and in quantity ought not to cost more than ten or twelve cents, and may be obtained for even less at wholesale. Twenty-five to fifty pounds for three applications per acre will be required.

The barrel with pump attached may be mounted on a cart or wagon which will straddle two rows of potatoes, while the horse walks between them. One man will be required to pump, and another to hold the nozzle. With fifteen or twenty feet of hose five or six rows can be sprayed on either side of the team, so that little damage will be done in the necessary driving over the field.

H. H. LAMSON.

Digitized by Google

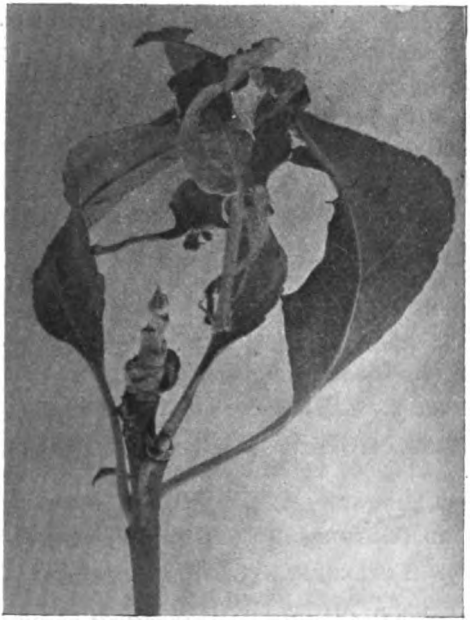
Sci 1636.35

in 23 November, 1894

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

ME DANGEROUS FRUIT INSECTS

BY CLARENCE M. WEED



NEW HAMPSHIRE COLLEGE
OF
GRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

CABOT SCIENCE LIBRARY

Digitized by Google

JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLE

OF

AGRICULTURE AND THE MECHAN

AGRICULTURAL EXPERIMENT

DURHAM, N. H.

BOARD OF CONTROL

Hon. GEO. A. WASON, *Chairman*, New B
Pres. CHAS. S. MURKLAND, *ex-officio*, Dur
CHARLES W. STONE, A. M., *Secretary*, Ea
Hon. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

President CHAS. S. MURKLAND, *Acting D*
HENRY E. ALVORD, C. E., *Agriculturist*
CHAS. H. PETTEE, A. M., C. E., *Meteorol*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriolog*
CLARENCE M. WEED, D. Sc., *Entomologis*

ASSISTANTS

EDWARD P. STONE, B. S., *Assistant Chem*
FRED D. FULLER, B. S., *Assistant Chemis*
FREDERICK W. HOWE, B. S., *Assistant in*
RUEL S. ALDEN, *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent to any resident o
upon application.

* Absent on leave.

Digitized by Google

E DANGEROUS FRUIT INSECTS

BY CLARENCE M. WEED

e of the evil effects of the changes which modern civiliza-
s made upon the earth is more evident to the American
than the increased difficulty of saving his crops from the
s of noxious insects and parasitic fungi. Many of us
eard from our fathers and grandfathers of the apples
once grew in abundance in yards and along highways,
rs alike to the codling moth, maggot, or scab, the
s peaches free from worms and rot, the plums unmarked
curculio, and the pears that had yet to learn the secret
oming dwarfed, gnarly, and cracked; of the grapes that
ot how to rot, and the potatoes which had neither been
d nor bitten by the Colorado beetle. Now all is changed:
rop has foes that often gather the lion's share of the har-
The enemies have come from the north and the south,
t and the west, from Europe and the islands of the sea,
our own midst they have flocked from the forest to the
eserting a wild plant for its cultivated congener, or chang-
ir habits to conform to a new environment.

increase of noxious insects, however, is the natural
f the changed conditions of things. Among the principal
tending toward it, may be mentioned: (1) the massing
s in limited areas; (2) the facilities for transporting
long distances by vessels and railways carrying agricul-
roducts; (3) the abandoned farms and orchards that
s breeding grounds; and (4) the destruction of forests
cultivation of prairies.

idering each of these factors briefly, we find that the
cy of the first—that of the massing of crops in limited

CABOT SCIENCE LIBRARY

Digitized by Google

areas—toward increasing our insect pests rests upon the biological law that the increase of any animal is limited by its food-supply. Under the natural conditions existing on this continent before the advent of the white man, those insects which fed on wild plants had, as a rule, only a limited food-supply. The apple maggot, or railroad worm, for example, is supposed to have bred originally in the wild haws of the woods. The parent flies had then usually to find here and there an isolated tree bearing the fruit in which it deposited its eggs. Its chances of being caught by a bird or entrapped in a spider's web while on this search were very good, so that the scarcity of the food-supply not only directly limited the number of individuals that could be produced, but by being scattered it increased the chances of the adult insects falling a prey to enemies. But in a modern apple orchard all this is changed: the food-supply is almost unlimited, and is so massed together that the insect runs little risk in passing from fruit to fruit, or from tree to tree. Hence it can multiply indefinitely, unless there is some means of checking it. The same line of reasoning applies to a large proportion of our injurious insects.

We are indebted to our commerce on sea and land for many of the most noxious insects. Brought to our shores from Europe, Asia, or Australia by ships, many of these pests have found a land which for them was flowing with milk and honey, and in which their hereditary enemies had not yet gained a foothold. Consequently they have multiplied without let or hindrance; and by natural and artificial means—notably the railroad trains—they have rapidly overrun the country of their adoption.

The abandoned or neglected fields and orchards all over the United States have proven a prolific breeding ground for many insect pests. Too often the efforts of painstaking farmers have been rendered unavailing by the proximity of such sources of infection. An orchard that has outlived its usefulness had better be converted into firewood than left to die uncared for.

The destruction of forests has compelled certain insects to resort to cultivated crops for subsistence; and in some cases a decided change in feeding habits has resulted. So, also, the bringing of the prairies into cultivation has caused many insects

Digitized by Google

originally fed on wild grasses, to resort to pastures and
ow lands.

e operation of these various causes, together with the enor-
powers of multiplication possessed by the insects them-
, has led to a constantly increasing injury to cultivated
until to-day these tiny foes exact a tribute of ten per cent.
e crop products of American agriculture. They form an
resent host of taxgatherers, taking possession of the far-
crops and enforcing their onerous demands without pro-
f law, unless preventive measures are vigorously prosecuted.
are no respecters of persons; like the rain, they fall upon
elds of both the just and the unjust.

he authorities best able to judge have estimated the annual
n the United States due to these little pests at nearly half
on dollars. Noxious insects, according to Dr. C. V. Riley,
tly the distinguished entomologist of our National Depart-
of Agriculture, occasion losses in the United States which
n the aggregate enormous, and have been variously esti-
l at from $300,000,000 to $400,000,000 annually.' In
states and single seasons the loss is often frightful in
t. During some of the great chinch-bug epidemics the
n Illinois occasioned by this one insect has amounted to
$73,000,000 a year; and in seasons not marked by an out-
of such a great crop pest the injury is much more severe
is ordinarily supposed. The official entomologist of the
just named, Professor S. A. Forbes—after years of careful
observation and statistical study—has recently expressed
elief that 'the insects of the state of Illinois derive as
a profit from the agriculture of this great agricultural state
the farmers themselves.'" *

rtunately, however, there is an extended silver lining to this
cloud of insect injury. If these creatures have increased
ery hand, our knowledge of methods of controlling them
lso augmented with the passing years. Many of the
lies proposed ten or twenty years ago, seem now foolish
impracticable. Within the last decade especially, the
ess has been phenomenal. It has been shown that many

* C. M. Weed, Popular Science Monthly, March, 1893.

CABOT SCIENCE LIBRARY

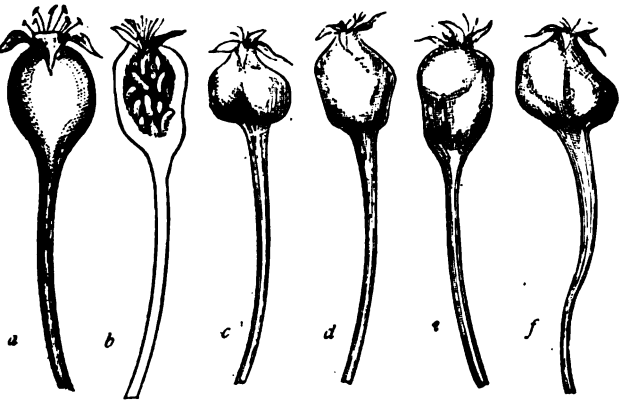
Digitized by Google

insects can be checkmated by a proper crop rotation; that the natural enemies of others can be used to destroy them; and that others are easily killed by improved insecticides. But the most important advance has been the introduction of the spraying machine, an apparatus by means of which insect killing substances may be easily and rapidly distributed over the surfaces of trees, shrubs, vines, and herbaceous plants. As I have elsewhere said, its introduction into American horticulture marks an advance almost as important as was marked by the advent of the improved cultivators into our agriculture. Before the latter were introduced the weeds that infest the soil were fought by the hand hoe, but now a single team does the work of many men. In the same way until recently various laborious and partially effective methods were used in fighting noxious insects and destructive fungi; but now many foes of both these classes are fought on a large scale by the force-pump and spray nozzle, and every season adds others to the list of those against which this method may be successfully used. With a large class of farmers and fruit growers, spraying has become a recognized part of the season's operations, and therein lies the chief promise of the method. When the belief becomes general that it is as important to save a crop from destruction by its foes as it is to produce it; that fighting noxious worms must take its place as a farm process by the side of that of fighting noxious weeds; that the parasitic plants which absorb the vitality of leaf and fruit are as dangerous to the crop as the plants which dispute with it the possession of the soil—and when along with this recognition there is placed before the farming community a cheap and wholesale method of preventing the injuries of these organisms, then the vast annual loss now suffered because of insects and fungi will be very greatly lessened.

The introduction of destructive insects still continues and is likely to continue for many years to come. At present there are two recently introduced insects that have not yet appeared in New Hampshire so far as known, but which are liable to reach us at any time and to become very destructive. I refer to the Gypsy Moth and the San José Scale. There are three other insects—the Pear Midge, Pear Tree Psylla, and Bud

Digitized by Google

n—which are probably present in some parts of the state, which have not yet become so injurious as they have in nboring states. The purpose of these pages is to warn the growers of the state of the threatened danger, and to give the information necessary for recognizing and combating pests when they do appear. For the facts I am especially bted to the publications of the Department of Agriculture, State Entomologist of New York, and the experiment sta- of New Jersey and the Cornell University. The illustra- have come from the same sources, and should be specifi- credited as follows: After Slingerland, Figs. 3–8; after ard, Figs. 10–14; after Taschenburg, Figs. 15–18; after ner, Fig. 1; after Riley, Fig. 2.



1. Pear Midge Injury: *a*, uninjured young pear; *b*, infested pear cut open to show midge larvæ; *c*, *d*, *e*, *f*, outlines of infested fruits.

The Pear Midge

Diplosis pyrivora

his insect appears to have been introduced into America t 1877, being first noticed in Connecticut. It has e spread into a number of neighboring states, and has me in many localities the most destructive enemy of the . The adult is a small mosquito-like grayish fly (Fig. 2, *c*) ng a slender body, long legs, and a long ovipositor project-

CABOT SCIENCE LIBRARY

Digitized by Google

ing from the end of the abdomen. These flies appear in the pear orchard in early spring, even before the blossoms open, and continue present about ten days. As soon as the blossoms open sufficiently for the insect to insert its ovipositor, the eggs —often nearly a dozen in number—are deposited inside the blossom envelopes. Three or four days later the eggs hatch into little maggots which enter the open ovary of the embryo fruit, where they feed upon the growing tissues, gnawing and rasping it in such a manner as to destroy the core and seeds, and cause the fruits to become dwarfed and deformed. Such pears are ill-shapen in outer appearance, as shown in the series represented in Fig. 1. The midge maggots at first are whitish in color, but they soon become orange or reddish. They become full-grown early in summer: they are then "about one-

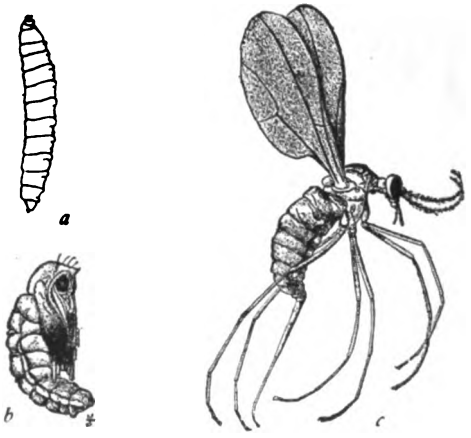


FIG. 2. Pear Midge: *a*, larva; *b*, pupa; *c*, parent fly. Magnified.

sixth of an inch in length, pointed towards each extremity, yellow in color, with a brown, horny breast bone on the under side just behind the head. The segments of the body are well-marked, and when removed from the infested fruit they move about quite rapidly, bending themselves quite double by drawing the tail forward until it touches the head, and then jerking or springing upward and outward several inches at a time.

Digitized by Google

they are full grown they remain in the fruit until there a rain, which causes a rapid decay and a cracking open e infested fruit. Through the openings so made they ge and drop to the ground." * They then enter the soil ch or two where somewhat later they make oval cocoons mixed with particles of earth or sand: in these cocoons apparently remain unchanged until the following spring they become pupæ and shortly afterwards again change lt flies.

ese midges appear to have decided preferences among va- of pears, the Lawrence being the favorite.

nedies.—The only stage at which this insect is liable to without detriment to the trees is when the larvæ are in round. Professor J. B. Smith of New Jersey has found ney then can be destroyed to advantage by the application init applied about the middle of June to the ground th the trees at the rate of 1,000 pounds to the acre. This solved by the soil moisture and causes the death of the midge larvæ. In case an orchard is generally infested sor Smith recommends the following practice: "Cultivate ual, or, if the orchard is in grass or clover, plow under June 15th, as soon as may be. Top-dress with kainit, pounds to the acre, to benefit trees as well as to kill in- As soon as proper, say early in August, sow crimson . This will use up the potash not required by the fruit and will store nitrogen, as well as occupy the ground. in the following spring turn this sod under as deeply as e proper. It should be done before the pear buds are ped, in order to head off and destroy any midges then in pa state near the surface of the soil."

The Pear-tree Psylla

Psylla pyricola

s is an extremely minute insect, which during recent years one great damage to pear orchards in several eastern

* J. B. Smith.

CABOT SCIENCE LIBRARY

Digitized by Google

states. It was apparently introduced into Connecticut early in the present century; since then it has spread west to Ohio, Michigan, and Illinois, south to New York and New Jersey, and probably over much of New England, though here it has been reported as destructive only in Massachusetts and Connecticut.

FIG. 3. Pear Psylla. Magnified.

The adult pear psylla is a small, jumping louse about one tenth of an inch long, resembling, when magnified, Fig. 3. It has four nearly transparent wings, and is reddish with transverse dark stripes on the abdomen. There are two distinct forms. The summer broods are much lighter in color than the brood which passes through the winter. This difference is so great that the two forms were considered distinct species until the life history was carefully worked out by Mr. M. V. Slingerland.

The dark form passes through the winter in some sheltered situation about the tree, such as beneath loose bark, or in the crevices between the branches. In early spring they come forth from their hiding places and deposit their eggs about the buds and on rough bark. These eggs are very small, and of the extraordinary form represented in Fig. 4. When first deposited they are yellowish, but turn dark soon afterwards. The eggs hatch in three or four weeks, the time depending largely on weather conditions. The young psyllas, which during their immature stages are called nymphs, crawl to the stalks of the unfolding leaves, in which they insert their tiny beaks to suck out the sap. They grow rapidly, occasionally moulting or shedding their skins to provide for their increase in size, and in the course of a month become mature.

The first summer brood thus developed deposits eggs on the under sides of the leaves. These eggs hatch ten days later, and mature in about three weeks. The insects of the second brood suck the sap from the leaves. There are several of these summer broods, the number varying with the

FIG. 4. Egg. Magnified.

Digitized by Google

locality and length of season. In early autumn the dark, hibernating winter form is developed.

The sap which passes through the bodies of these little creatures is ejected on the foliage, and forms the so-called "honey dew." Where the insects are very numerous this becomes very abundant, falling in showers when the branches are disturbed. After the honey dew has been present for some time a peculiar black fungus develops upon it, and gives the tree a sooty appearance.

Mr. Slingerland makes the following statement concerning the indications of the presence of the pest: "Among the first indications that pear growers, who suffered from this pest in 1891, had of its presence, was the noticeably lessened vitality of their trees early in the season. Old trees, especially, put forth but little new growth. Where new growth started, in many cases the shoots began to droop and wither in May, as if from a loss of sap. A little later, whole trees put on a sickly appearance; the leaves turned yellow and the fruit grew but little. By midsummer nearly all the leaves and half-formed fruit fell from many trees."

Remedies.—This insect can be destroyed by spraying in spring after the eggs hatch out and before the first brood matures, with kerosene emulsion diluted with twenty-five parts of water. This is a simple and satisfactory remedy; if applied soon after a shower has washed off much of the honey dew it is more effective.

The Bud-worm

Tmetocera ocellana

There is evidence to show that this insect was introduced to America from Europe early in the present century. It now occurs over a large portion of Canada and the United States, and sometimes is very destructive over wide areas, occasionally becoming the most serious orchard pest of the season. As soon in spring as the buds begin to open, the little caterpillars may commence work upon them, gnawing the miniature leaves and blossoms, but the attack is more likely to begin after the

Digitized by Google

buds about half open. The larvæ then eat out the the buds, where the leaves and flowers are least The caterpillar forms for itself a protecting case by u threads to bind together the leaves. As the seasor some of the leaves are killed, become detached at th turn brown; the blossoms also are more or less webb the smaller branches present an appearance sim accompanying illustration. (Fig. 6.)

The life-history of this insect may be summarized The moths appear in the orchard early in summer; light they rest upon the bark of trees or other shelte they fly about and deposit their eggs, one in a place on the under side of the leaves. About ten days later these eggs hatch into small green larvæ, which feed upon the epidermis of the leaves, each making for itself a silken tube and a thin layer of silk for protection and concealment. or two the green color changes to brown.

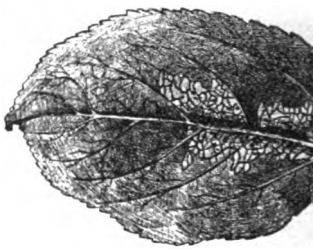


FIG. 5. Apple leaf showing wo bud-worm.

"As the larva increases in size and the area ov feeds becomes larger, the tube is enlarged and lengtl the midrib, sometimes becoming nearly one inch The silken web under which the larva feeds covers field of operations, but is so thin near the edges larva has last fed as to be scarcely visible. The e the larva being retained by the web appears as littl lets scattered here and there over the feeding ground

The green portion of only one side of the leaf i veins and veinlets being left untouched: these an of the opposite side die and turn brown, and thus l spicuous.

* M. V. Slingerland.

Digitized by Google

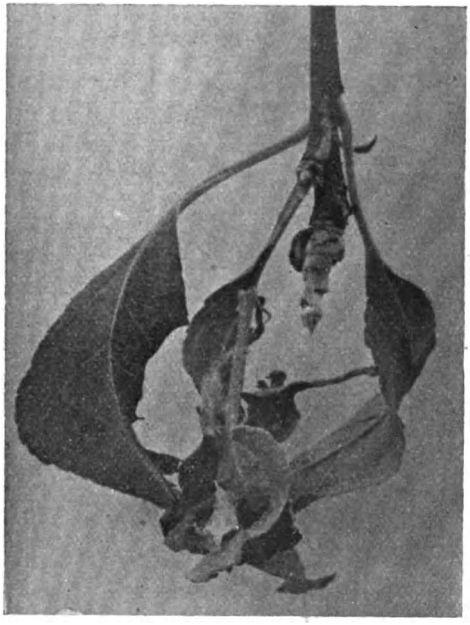


FIG. 6. Work of bud-worm among opening leaves.

te in summer or early in autumn the half-grown caterpillars
t the leaves and crawl upon the twigs, where they form
silken cases, generally near the buds or in creases in the
(Fig. 7.) In these they remain throughout the winter. The
ving spring they emerge to feed upon the opening leaves.
again make tubes, which serve as protective cases. After
ng six or seven weeks they become full-grown: then they
silken cocoons, generally in a rolled leaf or between two
s, in which they change to pupæ, to emerge a short time
as moths.

e full-grown larvæ are cinnamon brown in color with the
legs, and shield behind dead black. They are about
n inch long and of the general form shown in Fig. 8, *c*.

CABOT SCIENCE LIBRARY

Digitized by Google

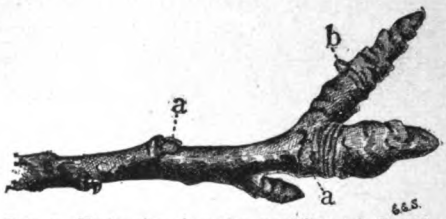


FIG. 7. Twig showing the position of the winter homes of the larvæ at *a*, *a*, and *b*, natural size.

The moth
a general re
the comm
moth. It
gray with
blotches o
wings, whi
little more
inch.

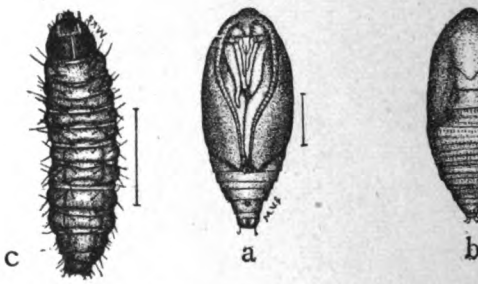


FIG. 8. Bud-worm: *a*, pupa, front view; *b*, pupa, back v
Magnified.

Remedies.—These little pests can most suc
destroyed by spraying with the arsenites early in spring when the buds are opening and the larvæ just beginning the season's work. It is advisable to use the Bordeaux mixture and Paris green combination in order to prevent injury by other fungous maladies as well as insects.

FIG. 9. Bud W

The San José Scale

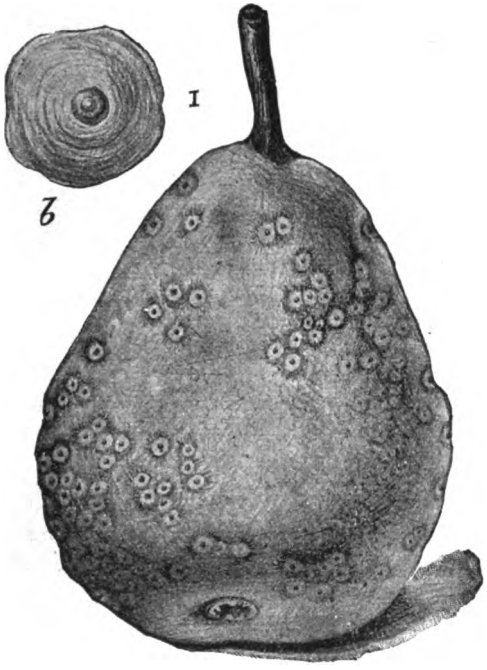
Aspidiotus perniciosus

This insect is related to the common oyster-she
but can at once be distinguished from the latter b
teristic round scale—as shown at *b*, Fig. 10.

Digitized by Google

infests practically all kinds of deciduous fruit trees and molested is liable to kill them. It was introduced into ornia from Chili about 1870, since when it has spread over ge portion of the Pacific slope; and has lately appeared in astern states, where it threatens to do much damage.

r. L. O. Howard describes the San José Scale as "per- y round, or at most very slightly elongated or irregular. It at, pressed close to the bark, resembles the bark of the



o. San José Scale: *a*. pear, moderately infested—natural size; *b*, female scale—enlarged.

s in color, and when fully grown is about one-eighth of an in diameter. At or near the middle of each scale is a l, round, slightly elongated black point; or this point may etimes appear yellowish. When occurring upon the bark e twigs or leaves and in large numbers, the scales lie close ach other, frequently overlapping, and are at such times

CABOT SCIENCE LIBRARY

Digitized by Google

difficult to distinguish without a magnifying glass. The general appearance which they present is of a grayish, very slightly roughened scurfy deposit. (Fig. 11.) The natural rich reddish color of the limbs of the peach and apple is quite obscured when these trees are thickly infested, and they have then every appearance of being coated with lime or ashes. When the scales are crushed by scraping, a yellowish oily liquid will appear, resulting from the crushing of the soft yellow insects beneath the scales, and this will at once indicate to one who is not familiar with their appearance the existence of healthy living scales on the trees."

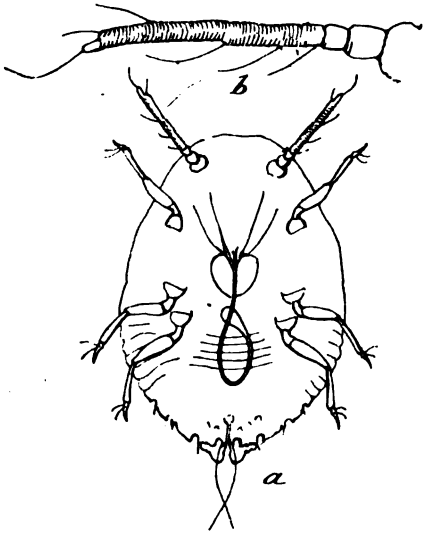
FIG. 11. San José Scale: Apple Branch, with scales in situ—natural size; enlarged scales above, at left.

The young scale lice hatch from eggs beneath the female scales, in spring, soon after the unfolding of the leaves. They are minute yellowish creatures, resembling Fig. 12 when highly magnified; they crawl about over the bark a short time, and finally fasten themselves to it, generally on the new growth, where they secrete a scale and there develop. Some of them mature into little two-winged creatures, resembling, when magnified, Fig. 14; these are the males: others develop into females, which do not become winged but remain on the bark in a fixed position. In the bodies of these the young are produced, as shown in Fig. 13.

When the San José scale occurs upon older trees, it is most likely to be found on the twigs and smaller limbs, but upon young trees it may occur over the whole surface. But it does not confine its attacks to the bark, for the leaves and fruit are often infested: upon the latter there is a very characteristic purplish ring around each scale. These rings are well illustrated in Fig. 10. "Upon the leaves the insects have a tendency

Digitized by Google

ect along the midrib, on the upper side of the leaf, in one e quite regular rows, and also to some extent along the bs. The infested leaves turn brown, but do not have a cy to fall as a result of the damage."



San José Scale: *a*, young larva—greatly enlarged; *b*, antenna of same—still more enlarged.

s pest is most likely to be introduced into new localities nursery stock imported from infested regions. This is ed to be the way in which it was first brought to the n states. It is also likely to be carried upon fruit sent ket. In a given locality the insects are most likely to be l from tree to tree and orchard to orchard by the young awling upon insects and birds and then crawling off after ave lit upon other trees. They may also be blown about wind.

young lice are easily destroyed by spraying with kero- emulsion. But in cases where the insect is first intro- to a new locality, the infested trees should be burned to the outbreak.

CABOT SCIENCE LIBRARY

Digitized by Google

Concerning this Mr. L. O. Howard, entomologist to the U. S. Department of Agriculture, says: "The principal mode of spread is by commerce in nursery stock, cuttings, and fruit. The time will come in the immediate future when some kind of quarantine regulations will have to be established by states, or by large fruit-growing districts. Should this species already

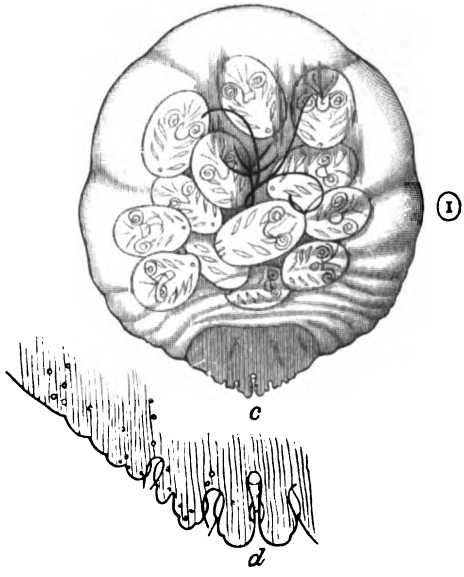


FIG. 13. San José Scale: *c*, adult female containing young—greatly enlarged; *d*, anal fringe of same—still more enlarged.

have obtained the firm foothold in the East which we suspect, New York, Michigan, and other states, in which the pomological interests are great, should immediately, by act of legislature, establish quarantine regulations similar to those in force at the present time in the state of California. In the meantime no orchardist should admit a single young fruit tree, or a single cutting, or a single bud, from a distance into his orchard, without first carefully examining it, and satisfying himself absolutely that

Digitized by Google

not carry a single specimen of the San José scale. If
ın is adopted by every one interested, and without excep-
e rate of spread of the species can be limited to the nat-
ɔread by crawling, by winds, and by the aid of other
and birds.

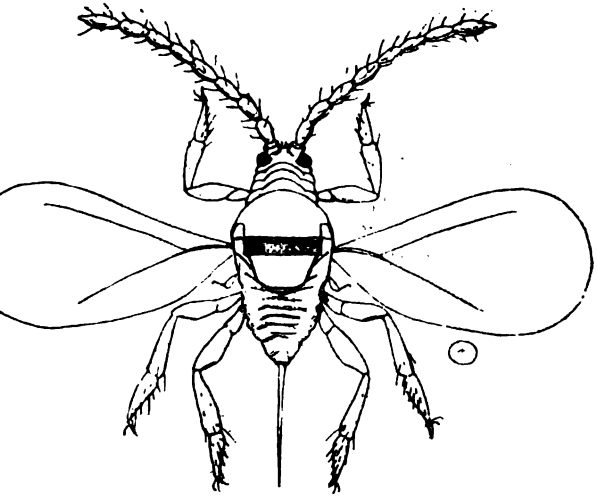


FIG. 14. San José Scale: male adult—greatly enlarged.

wish particularly to impress upon the minds of fruit-
s that as soon as this insect is found to occur in an
l the most strenuous measures must be taken to stamp it
No halfway measures will suffice. The individual must
ber that not only are his own interests vitally at stake,
se of the entire community in which he resides. Trees
nfested should be instantly burned, as previously stated.
dividual may think that he cannot bear the loss, but the
consequence of the slightest neglect will be much greater.
ct, too, that there is a community of interests among fruit-
s in this matter must not be lost sight of. Fruit-growers
e mutually helpful in an emergency like this."

CABOT SCIENCE LIBRARY

Digitized by Google

The Gypsy Moth

Ocneria dispar

Fortunately this notorious insect, which our Massachusetts neighbors are striving hard to subdue, has not yet been found in New Hampshire. It is sincerely to be hoped that it may never be found here; but as we are so near the infested territory it seems worth while to include in this connection a brief notice of the pest.

The Gypsy moth is one of the most troublesome insects in Europe. It feeds on an extraordinary variety of plants, attacking almost everything, and is difficult to destroy by natural or artificial means. As is well known it was introduced into the vicinity of Boston twenty-five years ago, and has since become very destructive in that region. In 1891 the legislature of Massachusetts established a commission for the extermination of the insect, and has since appropriated a large amount of money to carry on the work, which has already checked the outbreak to a remarkable degree. It is much to be hoped that the work will be continued unabated for several years.

FIG. 15. Gypsy Moth. Male.

There is an idea somewhat prevalent that this insect could be exterminated by importing parasites, but this is fallacious. In my opinion it would be a great mistake to abandon the work of extermination and leave it to be done by parasites. Under the most favorable conditions there could only result a long series

FIG. 16. Gypsy Moth. Female.

Digitized by Google

of oscillations in the numbers of the moths, in which periods of destruction would alternate with periods of immunity.

The later stages of the Gypsy moth are illustrated in the accompanying figures. The male moths are much smaller than

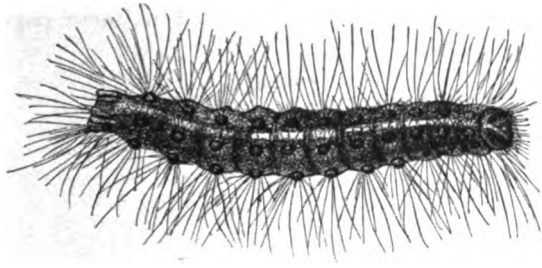


FIG. 17. Gypsy Moth Caterpillar.

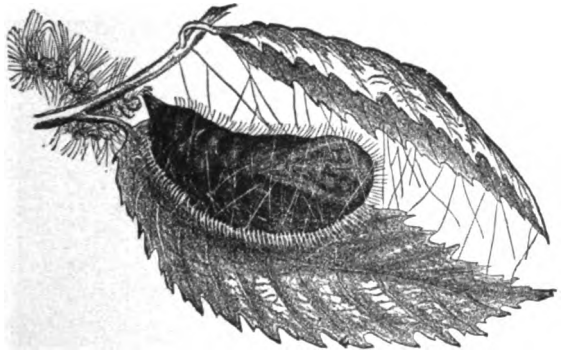


FIG. 18. Chrysalis of Gypsy Moth.

the females. "The full grown caterpillar is about an inch and three fourths in length, very dark brown or black, finely reticulated with pale yellow. There is a pale yellow line along the middle of the back and a similar one along each side. On the first six segments following the head there is a bluish tubercle, armed with several black spines on each side of the dorsal line, and on the remaining segments these tubercles are dark crimson red. In the middle of the tenth and eleventh segments there is a smaller red tubercle notched at the top. The whole surface

Digitized by Google

of the body is somewhat hairy, but along each side the hai
long and form quite dense clusters." *

Should any one in New Hampshire find an insect ansv
to this description they would confer a favor by sendi
securely packed, to the writer. Information concernin
presence of any of the pests described in these pages
also be appreciated.

* Fernald.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

letin 24 February, 1895

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE FLOW OF MAPLE SAP

BY A. H. WOOD

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

Hon. GEO. A. WASON, *Chairman*, New Boston.
Pres. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHAS. W. STONE, A. M., *Secretary*, Andover.
Hon. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

President CHAS. S. MURKLAND, *Acting Director.*
HENRY E. ALVORD, C. E., *Agriculturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

EDWARD P. STONE, B. S., *Assistant Chemist.*
FRED D. FULLER, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent to any resident of New Hampshire upon appliction.

Digitized by Google

THE FLOW OF MAPLE SAP

BY A. H. WOOD.

NOTE.—Professor Wood resigned his position on the Station Staff November 1, 1894.

This bulletin is chiefly based upon observations made while engaged in procuring samples of maple sap for investigation as recorded in Bulletin No. 25.

These results are submitted at this time, not as a complete study of the subject, but because the results recorded may be of immediate value to the sugar makers of the state.

It has become a common practice to tap maples to a depth of only about an inch. This practice is based upon the belief that the flow of sap comes chiefly from the wood of very recent growth, and that to tap beyond the growth of the last six or eight years is a useless expenditure of labor and an unnecessary injury to the tree.

To determine as to the correctness of this belief, as well as to investigate the comparative richness of the sap from the outer and inner wood, the following experiments were made. In the spring of 1892, two thrifty rock maples about fourteen inches in diameter and growing in thick woodland were selected and tapped as shown in Table 1.

TABLE 1.—RELATION OF DEPTH OF TAPPING TO FLOW OF SAP.

1892.	TREE A.		TREE B.	
	1¾ inches deep (south).	3½ inches deep (north).	1¾ inches deep (north).	3½ inches deep (south).
March 25	5.0 lbs.	8.0 lbs.	7.0 lbs.	8.0 lbs.
" 26	3.5 "	3.0 "	1.5 "	3.5 "
" 28	4.0 "	6.0 "	1.5 "	3.0 "
" 30	7.5 "	14.0 "	2.0 "	6.0 "
April 1	8.0 "	16.0 "	2.0 "	6.0 "
" 4	2.0 "	5.0 "	1.0 "	3.0 "
" 10	11.0 "	19.0 "	8.0 "	17.0 "
" 12	8.5 "	18.5 "	8.0 "	20.0 "
" 16	4.0 "	16.0 "	5.0 "	15.0 "
	53.5 lbs.	105.5 lbs.	36.0 lbs.	81.5 lbs.

Digitized by Google

The 1¾ inch holes yielded 89.5 pounds of sap, while the inch holes gave a little more than double that amount, o pounds.

In 1893, tree 8 was tapped twice, one hole being 1¼ deep, and the other 2½ inches. Tree 9 was tapped 2½ i deep, and tree 10 1¼ inches. These trees were large, th shade trees. The rate of flow was determined by notin amount of sap that flowed in two minutes, and in Table amount is expressed in cubic centimeters.

April 9th, the 1¼ inch holes were deepened to 2½ in the rate of flow being taken just before and after the deepe

TABLE 2.—RELATION OF DEPTH OF TAPPING TO FLOW OF SA

1893.	Time.	Tree 8.		Tree 9.	Tre
		1¼ inch.	2½ inch.	2½ inch.	1¼ i
March 14...	11:30 a. m.	15.0 c.c.	26.0 c.c.	46.0 c.c.	22.0
" 14...	3:00 p. m.	6.0 "	12.0 "	22.0 "	15.0
" 21.....	10:00 a. m.	6.0 "	6.5 "	8.5 "	7.5
" 22...	3:00 p. m.	7.0 "	12.0 "	11.0 "	7.0
" 25...	10:00 a. m.	4.0 "	7.0 "	5.5 "	4.5
" 25...	3:00 p. m.	3.0 "	5.5 "	4.0 "	2.0
" 27...	10:00 a. m.	2.0 "	6.0 "	12.0 "	6.0
" 27..... ...	2:00 p m.	16.0 "	26.0 "	26.0 "	15.0
" 29..... ...	3:00 p. m.	15.0 "	18.0 "	20.0 "	12.0
April 9...	11:00 a. m.	7.0 " Deepened to 2½ in.	24.0 "	12.0 "	4.0 Deep to 2
" 9.....	11:00 a. m.	21.0 c.c.	22.0 "	12.0 "	18.0
" 11...	10:30 a. m.	14 0 "	17.0 "	12.0 "	12.0
" 11.....	3:00 p. m.	6.0 "	7.0 "	.....	.....
" 12...	9:30 a. m.	31.0 "	37.0 "	47.0 "	44.0
" 20...	11:00 a. m.	9.0 "	17.0 "	14.0 "	9 0
Av. rate before April 9.....	11:00 a. m.	8.4 "	14.0 "	16.7 "	9.5
Av. rate after April 9.....	11:00 a. m.	16.2 "	20.0 "	17.0 "	16.6

In this trial, the deepening of the 1¼ inch holes brough rate of flow from these holes nearly to an equality with from the holes originally 2½ inches deep. The increa especially noticeable if a comparison is made between the of flow just before and after deepening.

April 17th, a tree about 12 inches in diameter was tapp inches deep with a 1 inch bit, the hole was then bored 2 i deeper with a ½ inch bit. An iron spout was driven int

Digitized by Google

er hole, and an old fashioned sheet iron spout driven under outer one, so that the sap from the inner and outer wood ıld be gathered separately.

At the time of tapping, the rate was: Inner hole, 9 c.c. per ıute ; outer hole, 6 c.c. per minute.

Three days later, April 20th, the run was 11 c.c. and 3 c.c. pectively. Thinking that the greatly decreased flow from the er hole might be due to the free exposure of the sap-wood to air, another similar tree was tapped in the same manner. e rate of flow from this second tree was 16 c.c. from the ıer, and 13 c.c. from the outer hole. In both trees the flow m the inner wood exceeded that from the outer wood, al-ıugh the diameter of the outer hole was double that of the ıer one.

In 1894 four trees were tapped as follows: *R* tapped 2⅞ hes deep with a $\frac{13}{16}$ inch bit, and the hole continued 2⅞ inches h a ⅜ inch bit. An iron spout was driven into the inner le, and the outer hole was closed with a rubber stopper rough which tubes were passed to give outlet to the sap from e outer and inner wood without subjecting the outer wood to posure to the air: *S* tapped 5½ inches deep with a ½ inch . A thin rubber stopper, through which a small tube was ssed, was driven to the centre of the hole, the tube extending t through the centre of the spout driven into the outer wood the tree. We were thus able to compare the rate of flow from e outer and inner wood with the same bore throughout: *T* ıped twice with a ⅜ inch bit. The holes 4 inches apart and parently in equally favorable positions, one hole 6 inches ep, the other 2 inches deep: *U* standing near and similar to tapped with a ¼ inch bit, 6 inches deep. Table 3 gives the e per minute in cubic centimeters.

Digitized by Google

TABLE 3.—RELATION OF DEPTH OF TAPPING TO FLOW OF S

1894.	R.		S.		T.		
	3/8 in. Inner.	13-16 in. Outer.	1/2 in. Inner.	1/2 in. Outer.	3/8 in. 6 in. hole.	3/8 in. 2 in. hole.	6 i
Mar. 17..	10.0 c. c.	14.0 c. c.	7.5 c. c.	4.5 c. c.	.....	.....	..
" 24..	6.0 "	5.0 "	9.5 "	4.5 "	25.0 c. c.	3.0 c. c.	1
" 26..	8.0 "	6.0 "	13.0 "	6.5 "	19.0 "	4 5 "	1
" 29..	3.5 "	3.0 "	.....	.....	3.0 "	0.3 "	
" 31..	6.0 "	4.5 "	8.5 "	7.5 "	14.0 "	0.2 "	1
Average	6.7 c. c.	6.5 c. c.	9.6 c. c.	5.8 c. c.	15.2 c. c.	2.0 c. c.	1

Diameter of hole.	Hole 5 3/4 in. deep. 3/8 in. and 13-16 in.	Hole 5 1/2 in. deep. 1/2 in.	Hole 6 in. deep. 3/8 in.	Hole 6 i 1/4
Aggregate rate of flow.	13.2 c. c.	15.4 c. c.	15.2 c. c.	13.5

Although the rate of flow was taken but a few times in the results are in each case, in accord with those of the p ing years.

The flow from the inner wood of tree R exceeded that the outer wood although the inner hole was less than ha diameter of the outer hole.

In S, with a hole of uniform diameter the flow from the wood was almost double that from the outer. The rema difference in the rate of flow from the 6 inch and 2 inch ho tree T, raises the question as to the effect of a deep hole the flow from a shallow one near it. A reference to ta shows that deepening the shallow hole in the tree 8, in 18 once decreased slightly the flow from the deeper hole. rate of flow from tree U is of interest, as showing the flow from a deep, but small hole. A comparison of the r flow from holes of nearly equal depth but of various diar is afforded by these four trees, as shown in table 3.

The only conclusions that can possibly be drawn fro result of these trials as shown in the three preceding tab that the flow of sap is very largely dependent upon the de

Digitized by Google

ping; that the theory that all or nearly all of the sap comes
m the outer wood is erroneous, and that our sugar makers
y with great profit, tap their trees to a depth of four or five
hes. The additional injury to the tree is slight, especially if
hole is small and the bark but slightly hewn away. Where
⅝ inch bit is used and the bark practically uninjured by hew-
, a majority of the holes will be grown over the first summer
er tapping. If double the amount of sap can be obtained by
ping four inches deep, instead of two, and the sap be of nearly
ıal richness, then it is time to stop giving directions to tap
one inch deep as many have done on the assumption that
sap from the inner wood was scanty and poor.

In 1892 two trees with as uniform tops as could be found and
nding in thick woodland, were tapped both on the north and
ıth sides. A similar tree was tapped on the south and west
es. With trees 6 and 20, the south side yielded about 23
cent. more than the north side, while with tree 12, the west
e exceeded the south side by about 9 per cent. It is of in-
est in connection to depth of tapping to note that tree 6 was
ped 1½ inch deep, and trees 12 and 20, 2¼ inches deep.
with ½ inch holes. Table 4 gives the results in detail.

BLE 4.—FLOW OF SAP FROM NORTH AND SOUTH SIDES OF TREES.

1892.	6.		20.		12.	
	North.	South.	North.	South.	West.	South.
rch 25....	6.5 lbs.	6.5 lbs.	11.8 lbs.	10.0 lbs.	11.7 lbs.	12.2 lbs.
" 26....	2.0 "	2.5 "	6.5 "	7.0 "	3.0 "	3.5 "
" 28....	2.0 "	3.0 "	7.5 "	8.0 "	3.0 "	3.5 "
" 30....	3.5 "	5.0 "	18.7 "	22.7 "	4.0 "	4.5 "
ril 1....	4.0 "	6.0 "	16.0 "	18.0 "	5.0 "	5.0 "
4....	2.0 "	2.5 "	4.0 "	4.0 "	3.0 "	2.5 "
10....	8.5 "	10.0 "	19.5 "	22.0 "	15.0 "	11.0 "
12....	8.0 "	9.5 "	19.0 "	22.5 "	20.0 "	14.5 "
16....	13.0 "	16.0 "	7.0 "	16.0 "	27.0 "	26.0 "
Total....	45.5 lbs.	61.0 lbs.	110.0 lbs.	130.2 lbs.	91.7 lbs.	82.7 lbs.

A few observations made in 1893 and 1894 are in accord
h the results from trees 6 and 20. Without doubt differences
season and the exposure of the trees to the sun have much
do with the results from tapping on different sides of the

Digitized by Google

trees. As an illustration of the effect of the sun in som stances we will cite the following. In 1893 a thrifty standing in a small group of trees and exposed to the sun tapped on the north and south sides. The excess in fav the south side was almost wholly due to the yield upon when the sun shone brightly, but with the temperatur slightly above freezing; the yield was, south side, 11 po north side, 2½ pounds.

There can be little doubt as to the correctness of the mon practice of tapping the south side whenever practicab

There is a growing tendency to tap trees twice, puttir holes near together and letting the sap from both spouts into the same bucket. To test the profit of so doing the foll trial was made: Six maples from twelve to sixteen inch diameter, standing near together and with the same exp were divided into two groups, as nearly alike as possible ir spread of branches, etc.

The trees in group *A* were tapped once with a ½ inc and 1½ inches deep. Those in group *B* were tapped once with a ½ inch bit, and once with a ⅜ inch bit, the being 1½ inch deep and about 4 inches apart. Table 5 the yield by trees and by groups.

TABLE 5.—EFFECT OF TAPPING TREES ONCE AND TWICE

1892.	Group A. Tapped once.			Group B. Tapped twice.		
	14	15	16	17	18	
March 25	17.7 lbs.	18.5 lbs.	12.7 lbs.	19.0 lbs.	16.0 lbs.	1
" 26	6.0 "	7.0 "	6.0 "	8.2 "	6.0 "	
" 28	7.5 "	9.0 "	8.0 "	8.5 "	7.0 "	
" 30	19.0 "	22.0 "	21.7 "	22.0 "	17.5 "	1
April 1	20.0 "	19.0 "	19.0 "	22.0 "	17.0 "	1
" 4	5·5 "	4.0 "	8.0 "	5.0 "	3.0 "	
" 10	14.0 "	9.5 "	12.5 "	16.5 "	10.5 "	
" 12	14.0 "	13.0 "	15.0 "	23.0 "	14.5 "	1
" 16	12.0 "	6.0 "	16.0 "	14.0 "	14.0 "	
Total yield by trees..	115.7 lbs.	108.0 lbs.	118.9 lbs.	138.2 lbs.	105.5 lbs.	8
Total yield by groups		342.6 lbs.			331.6 lbs.	

The trees tapped but once gave slightly more sap than tapped twice. When we consider the similarity of the tr

Digitized by Google

the two groups and the nearly equal flow from all, with the exception of tree 19, it seems certain that little was gained in this case by tapping in the manner described. This is the result of a single trial, but if we remember that sugar makers have gradually changed from the use of the two-inch auger to the half and three eighths-inch bit for tapping, on the ground that they obtain nearly or quite as much sap with much less injury to the tree, is it not reasonable to expect that holes three or four inches apart should influence the flow from each other? This point has been referred to in connection with tree *T*, Table 3. More sap may frequently be obtained by this method of double tapping but the question arises whether, if we are able to tap a tree two or more times, it is not true economy to place the holes as far apart as possible, even if extra buckets are required for so doing.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

PURDUE UNIVERSITY Sci 1636.35
AGRICULTURAL EXPERIMENT STATION

Bulletin 25 March, 1895

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE COMPOSITION OF MAPLE SAP

BY F. W. MORSE AND A. H. WOOD

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE
NOV 15 1935
LIBRARY

Digitized by Google

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

BOARD OF CONTROL

Hon. GEO. A. WASON, *Chairman*, New Boston.
Pres. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
Hon. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

President CHAS. S. MURKLAND, *Acting Director.*
HENRY E. ALVORD, C. E., *Agriculturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

EDWARD P. STONE, B. S., *Assistant Chemist.*
FRED D. FULLER, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

e Bulletins of this Station are sent to any resident of New Hampshire application.

Digitized by Google

INTRODUCTION.

During the sugar seasons of 1892, 1893, and 1894, Profe
Wood and Morse conducted investigations of problems
nected with the maple sugar industry. Owing to the
period in which maple sap flows freely, it has been impo
to make as complete studies in one season as are necessa
accurate knowedge of the subject, and as seasons also var
entific conclusions cannot be drawn from the results of t
three years' experiments. Therefore the following page
tain facts which have been observed, but from which few g
alities may be deduced.

While the cane, beet, and sorghum have been exten
investigated and many figures recorded, the results of stud
maple sap, thus far published, are few in number. The th
and observations unsupported by details, are, however,
numerous, and the results stated in the succeeding article
agree with some and contradict others.

The work has been arranged, for convenience, under a
priate heads.

Digitized by Google

THE COMPOSITION OF MAPLE SAP

F. W. MORSE AND A. H. WOOD

Note. Professor Wood resigned his position on the Station Staff, November 1, 1894.

All work upon maple sap hitherto published, so far as the iter is aware, is recorded in Bulletin 5, Division of Chemistry, ited States Department of Agriculture. The results now ntioned are in several cases closely accordant with those in work mentioned, and are of value on that account.

In the sixth annual report of this station, a detailed descrip- n of these investigations has just been published, therefore in s bulletin only the most noteworthy results will be given.

The variation in percentage of sugar has been found to be de, and some trees have yielded sap which was hardly worth aporating. Trees with many branches, and exposed to the l effect of the sun, have been found to give the richest saps, d trees with small tops in a thick grove, or much shaded, ve given the poorest sap. The amount of sugar in the sap s not depended upon variety of maple, since soft maples have lded both as high percentages of sugar, and as low as rock ples.

The sap toward the close of the season has shown neither as ch sugar, nor as much solids as at the beginning of the sea- n. This change has not taken place at a uniform rate, but tead there have been fluctuations up and down.

VARIATION IN SAP FROM DIFFERENT TREES, MARCH 31, 1892.

Description of Tree.	Per cent. Saccharose.
Rock maple, with small top, in a grove	1.30
Rock maple, with medium top, in a grove beside cart path	2.30
Rock maple, with large, wide top, surrounded by tall, young pines	2.80
Rock maple, large pasture shade tree	5.60
Soft maple, with many small branches, in open ground	4.00
Soft maple, with wide-spread top, surrounded by pines	2.50

Digitized by Google

VARIATIONS IN SAP FROM DIFFERENT TREES. 1893.

	Description of tree.	[Date.	Saccharose.	T S
2.	White maple, situated in a group of maple and hickories; tall, with medium top....	March 22	2.80	
		" 25	2.20	
		" 30	2.90	
		April 13	2.80	
4.	Rock maple, near the above tree and similar in size and form. Tapped in two places. Average of results given for each date	March 22	3.40	
		" 25	3.25	
		" 30	2.88	
		April 1	2.75	
		" 16	2.45	
6.	White maple, shade tree by road side, medium size, many branches, well developed.....	March 22	4.90	
		" 25	3.30	
		" 27	3.40	
		" 30	2.90	
		April 1	3.00	
7.	Rock maple, shade tree by road side, taller and larger than 9, but similarly proportioned.....	March 22	3.20	
		" 25	2.80	
		" 27	3.10	
		" 30	2.90	
		April 1	2.90	
9.	Rock maple, shade tree by road side. About the same size as 10.	March 22	4.00	
		" 25	3.40	
		" 27	4.00	
		" 30	3.40	
		April 13	2.50	
		" 16	2.21	
		" 20	2.35	

Digitized by Google

The variation in composition of sap from different sides of a tree, has not been found to be wide nor constant. Two trees showed a decidedly higher percentage of sugar from the north side, one tree gave the advantage to the south side, while a fourth tree gave nearly equal percentages to both north and south sides.

COMPOSITION OF SAP FROM DIFFERENT SIDES OF A TREE, 1892 and 1893.

Description of Tree.		Date.	Saccharose.	Total Solids.
		1892.		
6. Rock maple, in a grove, tall with small top.	N. W. side.	Mar. 27	2.25	2.66
	S. W. side.	" 27	1.95	2.12
		1893.		
2. White maple, in a group of trees, tall with medium top.	N. side.	Mar. 25	1.70	
		" 30	2.60	
		Apr. 13	2.20	
	S. side.			
		Mar. 25	2.20	
		" 30	2.90	
		Apr. 13	2.80	
4. Rock maple, near (4.) and similar in size and form.	N. side.	Mar. 22	3.40	
		" 25	3.40	
		" 30	2.75	3.01
		Apr. 1	2.80	
		" 16	2.51	2.79
	Average.	.....	2.97	
	S. side.	Mar. 22	3.40	
		" 25	3.10	
		" 30	3.00	
		Apr. 1	2.70	3.01
		" 16	2.39	2.64
	Average.	.....	2.92	
12. Rock maple, in an open field, branches low and wide-spread.	N. side.	Apr. 8	2.80	
		" 10	2.95	
	S. side.	Apr. 8	2.40	
		" 10	2.35	
	E. side.	Apr. 8	2.60	
		" 10	2.60	
	W. side.	Apr. 8	2.20	

It has been claimed that the outer wood of the maple yields a richer sap than the inner wood. To test the correctness of this opinion, tree 13 was tapped with two holes as near together as possible; one hole being bored diagonally in order to keep near the bark, and the other bored toward the centre of the tree. Each hole was bored to the same depth on the bit. The result of this experiment was contrary to the above claim. Trees 8

Digitized by Google

and 10, which had been flowing since March 22 from hole inches deep, were then bored to a depth of 2½ inches in the holes on April 9. Samples of sap from each tree were before and after the increase in depth of holes. The r were the same as with tree 13, and furthermore, the percen of sugar continued to remain higher for the balance of th son than they were before the experiment.

On April 20 two more trees, *o* and *p*, were tapped by bo hole of large diameter to the depth of 1½ inches and the tinuing with one of small diameter to an additional depth inches. The sap was collected from the outer and inner by means of a double spout consisting of one tube withi other. The results this time agreed with the above claim.

In 1894, two trees, *r* and *s*, were tapped in a similar m with the exception that the outer hole was carried to a de 2⅞ inches, and the inner hole 2⅞ inches further. Aga results agreed with the claim.

VARIATION IN COMPOSITION OF SAP FROM OUTER AND INN WOOD. 1893.

Description of Tree.	Date.	Per cent. Saccharose.
Tree 8. Rock maple shade-tree by road side. Tapped first on March 22 to a depth of 1¼ inches. On April 9, after collecting the flow of sap, the hole was extended to the depth of 2½ inches.	Mar. 22	3.20
	" 25	2.90
	" 27	3.20
	" 30	2.60
	Apr. 1	2.50
	" 9	1.65
Hole bored deeper	" 9	2.05
	" 13	2.06
	" 16	2.03
	" 20	1.98
Tree 10. Rock maple shade-tree by road side. Tapped in the same manner as 8, and on the same dates	Mar. 25	4.00
	" 27	4.60
	" 30	3.30
	Apr. 1	3.50
	" 9	3.45
Hole bored deeper	" 9	3.75
	" 13	3.73
	" 16	3.68
	" 20	3.72
Tree 13. Large rock maple in an open field. Tapped with two holes near together. Hole bored diagonally, keeping near the bark	" 8	2.85
Hole bored toward centre, 4 inches in depth	" 8	3.00

Digitized by Google

VARIATION IN COMPOSITION OF SAP FROM OUTER AND INNER WOOD. 1893-1894.

Description of Tree.	Date.	Outer Wood.		Inner Wood.	
	1893.	Saccharose.	Solids.	Saccharose.	Solids.
o. Large rock maple in an open field. Tapped by boring a hole 1″ in diameter and 1½″ deep, and continuing the tapping with a ¼″ hole, 2″ in depth.....	Apr. 20	2.45	2.53	1.96	2.13
p. Small rock maple growing in a wood. Tapped as above	" 20	2.08	2.25	1.92	1.98
	" 25	2.00	2.17	1.85	
	" 26	2.10	2.30	1.75	1.94
	1894.				
r. Tall maple in a group of trees in open field; 12″ in diameter. Tapped with hole 13-16″ diameter and 2¾″ depth, continued by a hole 6-16″ diameter and 2¾″ depth.....	Mar. 13	2.66	2.81	1.90	2.04
	" 17	2.64	2.80	2.36	2.45
	" 22	2.58	2.74	2.05	2.13
	" 30	2.55	2.65	1.86	1.95
s. Rock maple in grove on south slope of a low hill. Diameter about 12″.....	Mar. 17	1.99	2.07	1.48	1.54
	" 22	1.86	1.91	1.45	1.56
	" 31	1.93	1.98	1.51	1.59

The variations in richness of sap due to the manner of tapping, have not yet been found sufficiently wide to justify any method which will lessen the flow of sap. By comparing the variations in composition with those of sap-flow given in Bulletin 24, it will be noticed that the methods giving the richest saps yielded the least in quantity.

Digitized by Google

SOME NOTES ON MAPLE SYRUP AND SUGAR

BY A. H. WOOD AND F. W. MORSE

In 1892 and 1893, some work was done in making maple syrup, but as has been said with regard to sap-flow, the seasons are short and often capricious, necessitating many repetitions of results before laws can be definitely laid down.

The spring of 1892 was a peculiar one, because after the sap had flowed for a period of about two weeks, warm weather ensued which caused the buds to start and stopped the bleeding; and at the end of ten days, the temperature fell, a succession of cold nights occurred, growth was checked and the flow of sap was renewed. The syrups of this second period were scarcely different in composition from those of the first period, except the very earliest.

Experiments in letting sap stand for several days before boiling, filtering sap, and rapid and slow evaporation had no decisive effect on the composition of the syrup.

The syrups from soft maples were somewhat inferior to those from rock maples both in color and flavor.

Delay in boiling sap did not seem to affect the color of the syrup, but injured its flavor. Sap that was kept five days and then boiled gave one of the lightest colored samples produced.

The rapidity of boiling had little influence on the color, samples of syrup from saps that we allowed to slowly simmer away, being as light colored as those from similar saps boiled rapidly.

The lightest colored samples were produced by boiling a quantity of sap until finished, without addition of fresh sap.

Digitized by Google

ample produced by boiling about two quarts of sap in a glass beaker until it was thick syrup, without addition of nd without skimming, had little more color than the sap which it had been made. This sap was from covered ets and was thoroughly strained through cloth before boil-

p filtered through quartz sand produced a syrup in no way ior to the preceding, while one filtered through bone lost almost entirely the characteristic maple flavor.

p mixed with rainwater gave a syrup objectionably dark ed.

produce a light colored and fine flavored syrup requires he sap be kept as free as possible from all impurities and ghly strained; that it be reduced to syrup with the least pulations possible, taking care in every part of the process neither sap nor syrup comes in contact with surfaces that n any way injure their quality.

COMPOSITION OF MAPLE SYRUP. 1892.

ESCRIPTION OF SAMPLE.	Saccharose.	Solids	Reducing Sugars.	Ash.	Purity.
st run, March 26.....	69.6	71.0		0.57	98.02
" "	70.2	71.5	0.22	0.68	98.17
e week later, April 2.....	65.8	68.4	0.23	1.10	96.18
" " "	41.0	43.9	0.14	0.46	93.40
t before warm period, April 4	66.0	70.3	0.13	1.15	93.87
" " " "	66.4	70.4	0.14		94.32
t after warm period, April 14	62.2	65.8		1.04	94.54
" " " "	60.1	64.9	0.18	1.15	92.62
e run, April 27.....	57.9	62.7	0.27	1.67	92.34
ite maple, April 2.....	68.9	70.8	0.14	0.60	97.31
" " April 16.....	48.2	50.1	0.13	0.60	96.20
" " April 18.....	47.8	47.8	0.12	0.59	96.56
n April 1. Boiled at 221° F....	67.5		0.19		
" Evaporated at low mperature 3 days, then boiled	56.4		0.09		
ne as 11, after standing 4 days	58.1		0.15		
ne as 7, after standing 5 days	65.7		0.23		
n April 14. Boiled at 217° F..	60.1		0.18		
" Filtered through ne black and then boiled....	63.1		0.25		
n April 14. Filtered through artz sand and then boiled....	56.6		0.15		
n April 14. Boiled at 215° F..	43.6		0.18		

Digitized by Google

COMPOSITION OF MAPLE SYRUP. 1898.

Syrup.	Date.	Saccharose.	Total Solids.	Reducing Sugars.	Ash.	Spec Grav
0. White maple.....	Mar. 25	65.4	68.0	0.225	0.407	1.32
13. Rock maple.....	" 25	61.8	67.2	0.200	0.670	1.32
12. Rock and white..	" 30	58.5	62.8	.....	.....	1.30
14. Rock maple. Soured sap.....	" 30	58.2	63.6	0.540	.....	1.31
15. Rock maple. Boiled with frequent addition of cold sap.....	Apr, 10	57.2	63.1	0.070	0.720	1.30
16. From same trees as 15. Boiled without adding fresh sap.....	" 10	61.9	68.5	0.216	.....	1.33

As a preliminary to the investigation of problems c
with the maple sugar industry, several samples of su
obtained from various sources and analyzed in orde
some knowledge of the composition of the article.

COMPOSITION OF MAPLE SUGAR. 1891.

Sample.	Saccharose.	Solids.	Reducing Sugars.	A
1. Dry sugar.....	93.3	98.3	0.63	
3. Dry sugar, very light color.....	87.3	95.4	2.69	
4. Dry sugar, very light color.....	90.5	96.7	0.92	
5. Dry sugar, very dark color.....	85.2	96.4	4.51	
6. Dry sugar.....	88.1	95.5	2.76	
7. Dry sugar.....	91.7	95.6	1.16	
11. Dry sugar, very light color.....	93.7	98.6		
2. Cake sugar, last run.....	76.8	91.0	7.08	
8. Cake sugar, soft.....	83.6	88.6		
9. Cake sugar, medium.....	85.9	90.8		
10. Cake sugar, hard.....	86.0	92.3		

Digitized by Google

e dry sugars contained more solids than cake sugars but urity co-efficient was as high in one form as in the other. sugars contained less saccharose and more reducing s than light sugars and had a much lower purity coefficient. 1892 a few samples were prepared under different condi- and the analytical results are given below.

COMPOSITION OF MAPLE SUGAR. 1892.

Sample.	Finishing Temperature.	Saccharose.	Solids.	Purity.
ly run. Very light, soft fine ain	230° F.	82.9	84.9	97.6
ly run. Light, coarse grain	235° F.	85.9	88.6	96.9
ly run. Clarified. Golden, edium grain	240° F.	84.8	88.0	96.3
ly run. Clarified and stirred. ner and lighter than 3	240° F.	85.6	88.5	96.7
ly run. Clarified and stirred til cold. Fine	240° F.	91.5	94.8	96.5
e run. Clarified. Burned ghtly; dark	240° F.	82.7	88.0	93.9
e run. Clarified and stirred. rned; lighter than 6	240° F.	83.9	89.5	93.7
up had fermented and become ghtly acid		58.1	89.0	65.3

arifying the syrup and stirring it while boiling improved the , and the stirring increased the amount of sugar and solids. bers 6 and 7, prepared in the same manner as 3 and 4, but a later flow of sap, yielded the same percentage of solids, onsiderably less sugar and burned slightly. This result is iar to results obtained at the Vermont Experiment Station. etin 26.)

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 26 March, 1895

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

ANALYSES OF FERTILIZERS AND WOOD ASHES

BY FRED. W. MORSE

EXPERIMENT STATION BUILDING

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Digitized by Google

JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STAT

DURHAM, N. H.

BOARD OF CONTROL

Hon. GEO. A. WASON, *Chairman*, New Boston.
Pres. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, East Concord
Hon. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

President CHAS. S. MURKLAND, *Acting Director.*
HENRY E. ALVORD, C. E., *Agriculturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

EDWARD P. STONE, B. S., *Assistant Chemist.*
FRED D. FULLER, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent to any resident of New Ham
upon application.

Digitized by Google

SPRAYING EXPERIMENTS IN 1894

BY H. H. LAMSON

The experiments recorded in this bulletin are a continuation of similar ones carried on in 1892 and '93, directed chiefly to the treatment of the fungous diseases of the apple, pear, and potato.

Numerous varieties of apples and pears are affected with the disease known as the *scab*, which is caused by the growth of a minute parasitic or fungous plant. Frequently very serious injury is done, both to the foliage and fruit, and some varieties are almost a complete failure on account of it. The scab grows on the surface of the leaves and fruit. On the leaves it grows in dark green or smoky spots and patches, frequently causing them to become much wrinkled; on the fruit the scab produces characteristic dark green or black spots, rounded in outline with sharply defined margins. When attacked early, the fruit is liable to be one-sided, and in many cases it is badly cracked.

PEARS

About two-thirds of a Flemish Beauty pear tree was sprayed and the other third left unsprayed. The spraying was done on April 30, May 22, June 15 and 30. 1 to 12 Bordeaux mixture (1 pound blue vitriol to 12 gallons of water; see under heading Bordeaux mixture) was used. The pears, when gathered, showed the following result:

	Unsprayed.	Sprayed.
1st quality,	23 per cent.	70 per cent.
2d "	67 "	30 "
3d "	10 "	

An increase of 47 per cent, apparently due to spraying.

Digitized by Google

The third quality in this and the following tables o
of pear experiments means fruit cracked as well as scab
A Louise Bonne pear tree was sprayed with 1 to 12 B
mixture on April 30, May 22, and June 15 and 30.
tree of the same variety was left unsprayed for com
The pears, when gathered, showed the following result:

	Unsprayed.	Sprayed.
1st quality,	4 per cent.	20 per cent.
2d "	93 "	80 "
3d "	3 "	

An increase of 16 per cent of first quality fruit. Ver
of the pears were classed as second quality on account
small size. The following table shows the percent
scabby pears on the two trees:

	Unsprayed.	Sprayed.
Pears free from scab,	58 per cent.	98 per cent
" more or less scabbed,	42 "	2 "

Giving an increase of 40 per cent of pears free from
the sprayed tree.

Five Lawrence pear trees were made the subjects of
experiment. Three were sprayed with 1 to 12 Bordeau
ture and two were left unsprayed. The spraying wa
on May 2, June 9 and 26, and July 26. The pears, whe
ered, showed the following result:

	Unsprayed.	Sprayed.
1st quality,	50 per cent.	67 per cent.
2d "	50 "	33 "

Giving an increase of 17 per cent of first quality p
the sprayed trees.

These pears were affected with two different species of
the *scab*, and what, for want of a better name, we hav
the "*moth patch*." The latter gives the fruit a dirty,
appearance, occurring sometimes in roundish blotch
frequently almost entirely covering the fruit. This
also affects some varieties of apples, e. g., the Greeni

Digitized by Google

Northern Spy. It is readily distinguished from the scab, ch usually occurs in darker, thicker, and more sharply de- d spots. The following table shows the percentages of b and moth patch on the sprayed and unsprayed trees:

	Unsprayed.	Sprayed.
Scab,	36.1 per cent.	3.5 per cent.
Moth patch,	98.9 "	1.3 "

Giving a decrease of 33 per cent of scab and 97 per cent of th patch on the sprayed trees.

APPLES

About forty Baldwin apple trees in the orchards of the col- e farm were sprayed with Bordeaux mixture. The apples n these trees and from unsprayed ones for comparison were hered and stored in the barn which was burned Nov. 3, '94. e apples were all destroyed. The apples from five trees only been sorted. Of these trees, two were sprayed and three prayed. The two trees were sprayed four times with 1 to Bordeaux mixture, viz., on April 28, May 23, June 13 and On May 23 and June 13, six ounces of Paris green per gallons was added to the Bordeaux mixture for the codling h. The following table shows the result:

	Unsprayed.	Sprayed.
1st quality,	58 per cent.	79 per cent.
2d "	23 "	14 "
3d "	19 "	7 "

Giving an increase of first quality in favor of sprayed trees 21 per cent.

The percentages of scabby and wormy fruit were:

	Unsprayed.	Sprayed.
More or less scabby,	33 per cent.	3 per cent.
Wormy,	17 "	6 "

the orchard of Mr. DeMeritt twenty-four Baldwin apple trees e sprayed with 1 to 12 Bordeaux mixture. The first spray- was done May 2, just as the leaf buds were beginning to

Digitized by Google

open. June 9, just after the blossoms had fallen, the tr
sprayed again. At this spraying six ounces of Paris g
fifty gallons was added to the Bordeaux mixture for the
moth. This spraying did considerable injury to the fo
that only half of the trees were sprayed a third time
26, Bordeaux mixture alone being used at this time.

When the apples were gathered, the fruit from eig
sprayed trees was saved for examination, and also
from eight unsprayed for comparison. Four of the
trees received three applications and four only two, b
to lack of time and conveniences, the apples were n
separate, so that the apples from the eight trees as
may be said to have received two and one-half spraying
following table shows the result:

	Unsprayed.	Sprayed.
1st quality,	20 per cent.	36 per cent.
2d "	58 "	42 "
3d "	22 "	22 "

Giving an increase of 16 per cent of first quality
favor of the sprayed trees.

The percentages of scabby and wormy fruit were:

	Unsprayed.	Sprayed.
Scabby,	79 per cent.	19 per cent.
Wormy,	20 "	8 "

The windfalls which were under the trees were p
before the fruit on the trees was gathered, and were so
counted. The following shows the percentage of wi
the total number of apples on and under trees:

	Unsprayed.	Sprayed.
Windfalls.	35 per cent.	23 per cent.

The windfalls showed:

	Unsprayed.	Sprayed.
Scabby,	50 per cent.	9 per cent.
Wormy,	59 "	32 "

Aside from the scab, much of the unsprayed fruit wa

Digitized by Google

another fungous disease, which made its appearance in form of dark brown spots varying in size from mere dots to ts one-sixteenth inch or more in diameter. The spots e usually slightly depressed or sunken below the gen- surface. The presence of this disease made it necessary elass many apples of good size and shape as seconds. The ayed apples were almost entirely free from this trouble. Our ervation indicates that the diseased spots tend to grow ger on the stored fruit and to serve as the starting points of ay.

n case of nearly all of the sprayed trees more or less injury done to the foliage by the second spraying, when Paris en was added to the Bordeaux mixture. The usual amount Paris green recommended is four ounces to a barrel, or fifty lons. In this case six ounces were used. It was thought, vever, that the lime in the Bordeaux mixture would prevent bad results, and we are at a loss to account fully for the ury done. It may perhaps be partly accounted for by the t that where the worst damage occurred the spraying was done a bright, hot day—a condition which is known to favor the urious tendencies of Paris green.

Lichens or Moss.—Many fruit trees are covered with differ- varieties of lichens or "moss," as they are often called. It question not yet decided how much direct injury they do to trees, but they are unsightly and offer protection to insects their eggs. The Bordeaux mixture is very effective in troying them.

Russety Fruit.—Among our sprayed apples we found some a rough or russety skin, and thought at first that it was to spraying, but we found that many unsprayed ones were as bad. In fact many apples last season showed this eting. The late frosts last spring, just as the trees were loom, were perhaps to blame for this. It must be noted, vever, that the Bordeaux mixture does sometimes produce a ilar effect. We also heard of numerous instances last fall Flemish Beauty pear trees which had not been sprayed, but ch produced a fair crop of pears; something unusual for this

Digitized by Google

part of the country. The pears were also unusually russety. It seems possible that the russety surface due perhaps to frost presented an unfavorable condition for the development of the scab fungus, and thus in a measure protected the fruit from its injuries.

POTATOES

In the case of potatoes the experiments were directed chiefly towards the prevention of the *Early Blight* and the *Scab*.

The following description of the early blight is reprinted from the New Hampshire College Experiment Station Bulletin No. 22.

EARLY BLIGHT

The early blight *(Macrosporium solani)* has come to be recognized as a serious disease of the potato only within the last two or three years. It was first noticed at this station in the summer of 1892. As its name indicates, it makes its appearance earlier than the ordinary blight—by the middle of July or earlier. It first appears, as sharply defined, rather irregular, dark brown or blackish spots on the leaves. The surface of the spots is usually marked with minute wrinkles, which take roughly the form of numerous circles with a common centre; this has been called the "target marking," from its resemblance to the concentric rings of a target. The spots increase gradually in number and size till the whole leaf is destroyed.

The fungus producing this disease differs considerably in the details of its structure from the late blight, but like it, consists of mycelial threads which grow in the tissues of the leaf and send out spore-bearing stalks on the surface. The early blight may be distinguished from the late blight by its characteristic spots, by the absence of the mould-like growth on the under side of the leaf in the case of the latter, by its earlier appearance and slower growth, and by the fact that it does not affect the tubers.

The experiments against the early blight were made in the Station potato field. On July 7, plots aggregating one and one-sixth acres were sprayed with Bordeaux mixture. Alternate plots aggregating four-fifths of an acre were left unsprayed

Digitized by Google

comparison. The spraying was repeated July 26, August 21, and September 4.

The early blight did not make its appearance in the field until ut the time of the third spraying, August 8, and did not in to seriously affect the unsprayed vines until two weeks r. By the middle of September, however, the unsprayed es were dead, while the sprayed vines, in varying proportions different parts of the field, were alive the first of October en the potatoes were dug.

Owing to the uneven character of the field and the effects of drouth, the yield of the sprayed plots as a whole could not compared with that of the unsprayed plots. Smaller plots each, as similar in character as possible, were chosen and the yields compared. Five pairs of plots were selected, h consisting of a sprayed and an unsprayed plot of equal e lying side by side. The sprayed plots showed an increase yield over the unsprayed as follows:

Pair No. 1 an increase of 29.1 bushels per acre.

"	2	"	31.9	"	"
"	3	"	54.7	"	"
"	4	"	26.4	"	"
"	5	"	21.3	"	"

The average increase per acre apparently due to spraying was bushels.

The cost per acre of each spraying was $3.52; for the five ayings, $17.60. The potatoes were sold for 60 cents per shel. At this price the 33 bushels were worth $19.80. Deting the cost of spraying, $17.60, there was left a profit of 20. This, as it stands, would not be a very brilliant result, there are several circumstances which should be taken into sideration along with it. It seems probable that three ayings, beginning the first of August, would have answered well as the five, beginning the seventh of July. Spraying was gun at this early date to make sure of getting ahead of the ght, which, however, did not appear till about the middle of gust. Had three sprayings only been made, the cost would ve been $10.56 and the profit $9.24 per acre. It is probable t owing to the drouth and the late appearance of the blight,

Digitized by Google

the difference in yield between the sprayed and unsprayed toes was not as great as it would be ordinarily. Aga possible that with the desire to make the treatment th more materials were used and more time taken than was necessary. At each spraying 150 gallons of Bordeaux per acre were used. The mixture was made according following formula:

Blue Vitriol.... 5 lbs.
Lime (Fresh)... 5 lbs.
Water.....50 gallons.

The blue vitriol cost, in 25 pound lots in Boston, 6 ce pound, and about 6½ cents laid down. The lime was pu in small quantities, and cost 1 cent per pound.

At these prices 150 gallons of Bordeaux mixture cost or about ⅔ of a cent per gallon. In spraying an acre, tw were employed eight hours at 15 cents per hour; th expense was $2.40. The actual time of spraying was six two hours were occupied in obtaining water, making th ture, etc.

It is probable that the expense for labor can be consi reduced. The total expense will vary with the luxuri the vines, the number of applications required, the loc of materials, the form of apparatus used, and the conv of water. It is our belief, however, that spraying aga early blight will be found to be a profitable operation.

Late Blight of the Potato.—The late blight, or the *rot*, as it is often called, makes its appearance usually the first of August. It is characterized by the rapid wi and dying of the leaves, and by the appearance on the side of the affected leaves of a fine white mold-like which consists of the spores and spore stalks of the producing the disease. The tubers are usually more affected. If the weather is warm and wet, the course disease is very rapid.

The early and the late blight are often present togeth

POTATO SCAB.

Within a few years it has been found that this serious

Digitized by Google

not caused, as has been supposed, by any condition of soil fertilizers, but by minute parasitic plants belonging to the ss known as bacteria. These little plants grow in the super- al portions of the tuber, where they act as an irritant, caus- a growth of the tissues, which results in the production of characteristic scab spots. A scabby crop of potatoes ults either from the use of scabby seed, or from planting on ound which has previously produced a scabby crop. The rms of the disease live on the harvested potatoes, and also an indefinite time in infected soil. When it was found that scab was caused by bacteria, it readily occurred to experi- nters that corrosive sublimate, a substance extensively used the destruction of other bacterial germs, might prove useful treating it. This has been tried, and the corrosive sublimate nd to be capable of destroying the germs on scabby seed, so t when the latter was planted on soil itself free from the rms, a smooth crop was produced.

An experiment in this line was tried here last summer. Po- oes of the Deleware variety, very badly scabbed, were used. evious to planting, half of the potatoes were treated with rrosive sublimate in the following way: Two and one-fourth ¼) ounces of corrosive sublimate were dissolved in two or ee gallons of hot water. This was poured into a half barrel d sufficient cold water added to make fifteen gallons in all. e potatoes contained in a coarse "feed" sack were placed in s solution and allowed to remain for an hour and a half. e sack of potatoes was then taken out and after draining the tatoes were emptied out and allowed to dry. They were en cut and planted. Treated and untreated seed were planted e by side in alternate plots of two rows each, on land which d not been plowed for many years and was therefore presuma- y free from scab germs. When the plots were dug the tubers marketable size were sorted into three grades, viz.: the first, actically free from scab; second, more or less scabbed; third, dly scabbed. The following table shows the results:

	Treated.	Untreated.
1st grade,	60 per cent.	31 per cent.
2d "	31 "	36 "
3d "	9 "	33 "

Digitized by Google

This shows that although the scab on the treated plots was not wholly prevented, it was greatly reduced. The seed which was very badly scabbed was not washed previous to treating it, and possibly the solution of corrosive sublimate did not penetrate to all parts of the scabby patches.

It would not be advisable, of course, to plant scabby seed even with this treatment, if clean seed could readily be obtained; but it is difficult to obtain seed in regard to which one can be certain that it is not more or less contaminated, for small patches of scab are easily overlooked. Tubers absolutely free from scab themselves, if selected from a bin in which there are a few scabby ones, would be liable to carry germs in the dirt adhering to them. In using such seed it would doubtless be beneficial to wash thoroughly in water alone, but better in the corrosive sublimate solution. The relation of fertilizers and conditions of soil to the development of scab has not yet been definitely made out, aside from the fact that they are not the direct cause of it. It seems likely that certain conditions of soil, existing naturally or produced by the use of certain fertilizers, are especially favorable to the growth of the scab plant when its germs happen to be present on the seed or in the soil.

The cost of treating the seed for an acre ought not to exceed $1.50 for both labor and materials. In the above experiment there was a gain of thirty bushels of marketable potatoes per acre on the treated plots.

As corrosive sublimate is a powerful poison, it should not be used carelessly.

BORDEAUX MIXTURE

The Bordeaux mixture is coming to be recognized as the most efficient among the many fungicides which have been tried during the past few years.

The ingredients of it are copper sulphate, which is commonly known as blue vitriol, or blue stone, lime and water. A large number of formulas, differing in the proportion of these ingredients, have been published.

Digitized by Google

The original formula, as published in this country, was Blue
riol, 6 pounds; Lime, 4 pounds; and Water, 22 gallons.
This has been found to be much stronger than necessary for
ctive work, and various degrees of dilution have been rec-
mended. The formulas for the dilute Bordeaux mixture
e been almost as numerous as the individual experimenters.
ile many of them have been practically identical in strength,
different wording and arrangement of proportions have been
fusing, so that the movement on foot among experimenters
a simplification of formulas seems wise.

We think the method of expressing the strength of the
xture suggested in N. Y. Agricultural Experiment Station
lletin No. 84, page 3, a good one. It is the first publication
the method which we have seen, but we have personally used
n our notes and computations for the last two years. This
in substance, to make some weight of the blue vitriol the
t of the formulas, and to express the strength by the pro-
tion of water used with it, *it being understood that a sufficient*
antity of lime is to be used. The pound naturally suggests
lf as the unit of weight for the blue vitriol, and the gallon
the unit of water.

According to this mode of expression the original formula
oted above, viz., 6 pounds of blue vitriol to 22 gallons of
ter would be 1 to $3\frac{2}{3}$; 1 to 8 Bordeaux mixture would be 1
nd of blue vitriol to 8 gallons of water; 1 to 12 Bordeaux
xture would be 1 pound of blue vitriol to 12 gallons of
ter. By using this method it is very easy to compute the
ount of materials necessary for any given quantity of the
xture.

The important ingredient of the Bordeaux mixture is the
oper sulphate, or blue vitriol. This alone, dissolved in water,
uld be an efficient fungicide; but it would so seriously injure
foliage of plants, that the remedy would be worse than the
ease. The object of the lime in the Bordeaux mixture is to
event this injury. This it does, when used in a sufficient
antity, by producing a chemical change in the solution of blue
riol which renders it harmless. The lime is also of use in
using the mixture to adhere more strongly to the sprayed
iage, so that it is not quickly washed off by rains.

Digitized by Google

As indicated by the original formula given above, two-thirds of a pound of lime has been found to be sufficient to neutralize a pound of blue vitriol. For convenience we have used and recommended equal weights of blue vitriol and lime. We do not know of any bad results from using this amount of lime.

Instead of weighing the lime a test has been in use during the past year or two which indicates when sufficient lime has been used. This test consists in adding a few drops of a solution of yellow prussiate of potash, or potassium ferrocyanide, as it is known chemically, to the Bordeaux mixture, when a brownish color will appear if too little lime has been used. More lime must then be added until the brown color fails to appear on adding a fresh quantity of the ferrocyanide solution. This test, when rightly used, is probably reliable. Instances are however reported of the Bordeaux mixture causing injury to foliage and fruit where this test has been used, probably from the fact that not quite enough lime had been used. It is therefore recommended that after the addition of the ferrocyanide solution ceases to produce the brown color, a still further quantity of lime should be added for safety, for a small excess is far better than a slight deficiency. Perhaps, under the circumstances, it would be safer to continue to weigh the lime, using two-thirds as much as of blue vitriol.

Perfectly fresh lime should be used. Air-slaked lime will not answer. It is therefore better to use only the lumps. Care should be exercised in slaking the lime. Water should be added only just fast enough to keep the lime wet. It should be kept thoroughly stirred after it begins to slake, as when any considerable quantity is used the bottom portions are apt to become dry and "burnt." After the lime is slaked, sufficient water should be added to make it of the consistency of fresh cream. It is then ready to be added to the solution of blue vitriol. The blue vitriol may be dissolved quickly in hot water, or the required amount may be placed in a basket or loosely woven sack and suspended in a tub or other wooden vessel of cold water. As fast as it is dissolved the solution, which is heavier than the water alone, will sink to the bottom of the vessel and a fresh portion of water will come in contact with the crystals

Digitized by Google

they are completely dissolved. About two quarts of water are required to dissolve a pound of blue vitriol. This good way of dissolving the blue vitriol when it is not wanted immediate use, and is preferable to putting the crystals in the bottom of the vessel, for in that case they will dis- very slowly unless kept constantly stirred.

ır actual practice has been to make a stock solution, by lving the blue vitriol in a sufficient quantity of hot water hen adding enough cold water to make half as many gal- as there were pounds of blue vitriol. Two quarts of this solution therefore represents one pound of blue vitriol. is a very convenient way, especially where small quanti- only of Bordeaux mixture are used at a time. A stock ion of lime also may be made. These stock solutions ld be carefully protected from evaporation.

e slaked lime should be strained before adding to the solu- of blue vitriol; or better still, perhaps, the completed Bor- x mixture should be strained before pouring into the pump in order to remove the coarser particles, which would be to clog the spraying nozzle. The straining may be done gh coarse sacking, or a wire strainer with a mesh about ixteenth of an inch wide.

e Bordeaux mixture should be kept thoroughly stirred up g the time of spraying. It is at its best for only a few after its preparation; it soon develops a greater tendency ttle and loses a part of its valuable property of sticking to oliage. We would recommend as a formula for Bordeaux ure for general use:

Blue Vitriol,	1 pound.
Lime, fresh,	2/3 "
Water,	10 gallons.

is makes a 1 to 10 mixture. To make a combined insecti- and fungicide, Paris green or London purple may be added e Bordeaux mixture, in the proportion of four ounces ound) to fifty gallons. This combination is useful in the ing of apple trees just after the blossoms fall, as it serves estroy both the scab and the codling moth. A second ing with it ten days or two weeks later is also advisable.

Digitized by Google

The combination may also be used for potato blight and bugs.

Paris green may be used with water in the proportion of four ounces to fifty gallons. A pound of fresh lime, or an equivalent quantity of slaked (not air-slaked) lime added to it, will lessen the danger of injury to foliage from its use. This answers for canker worm.

One of the most important points to be observed in the use of mixtures containing Paris green, is to keep them *thoroughly stirred up*.

RECOMMENDATIONS

Pear and Apple Scab.—Spray with Bordeaux mixture once before the blossoms open; again just after they have fallen, and then a third time after ten days or two weeks. Rainy weather may make a shorter interval and an additional spraying advisable.

At the second and third sprayings Paris green or London purple, in the proportion of four ounces to fifty gallons, may be added to the Bordeaux mixture for the codling moth.

Potato Blight.—For the early blight spraying with Bordeaux mixture should be begun by the middle of July, or sooner if the characteristic brown spots of the disease make their appearance. The spraying should be repeated twice, with an interval of ten days or a fortnight. If the weather is rainy, the interval between sprayings should be shortened and a fourth application may be advisable. This treatment will serve for both the early and the late blight. If it were known that only the late blight was to be dealt with, the spraying might usually be delayed till the last of July.

Digitized by Google

Sci 1636.35

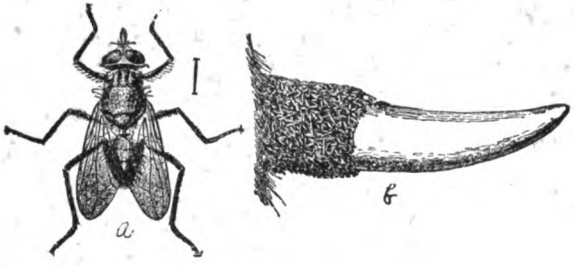
lletin 28 June, 1895

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

REMEDIES FOR THE HORN FLY

BY CLARENCE M. WEED



NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STAT

DURHAM, N. H.

BOARD OF CONTROL

Hon. GEO. A. WASON, *Chairman*, New Boston.
Pres. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover
Hon. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

President CHAS. S. MURKLAND, *Acting Director.*
HENRY E. ALVORD, C. E., *Agriculturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
LEIGH HUNT, *Horticulturist.*

ASSISTANTS

EDWARD P. STONE, B. S., *Assistant Chemist.*
FRED D. FULLER, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent to any resident of New Ha upon application.

Digitized by Google

REMEDIES FOR THE HORN FLY

BY CLARENCE M. WEED

bout eight years ago there appeared in some of the Eastern
es a fly which attacked cattle in a manner differing some-
from that of the common cattle pests. Its most peculiar
was that of congregating upon the base of the horn in
ers as shown in the right hand figure on the front page of
bulletin. On this account the insect became commonly
n as the Horn Fly, although it has since been found that,
rule, it thus clusters upon the horn only when very abun-
It may be present in annoying numbers without showing
habit.

ter its introduction into New Jersey, where it was first no-
in 1887, the Horn Fly spread rapidly in all directions.
few years it had covered, practically, the greater portion of
United States and Canada. It has been present in New
and for several years, and has been sufficiently abundant
use considerable annoyance in New Hampshire for at least
seasons. The present summer it appears to be more
dant than ever.

he Horn Fly is a small, two-winged, six-legged, grayish-
fly about one-fifth of an inch long. As compared with
ommon house-fly it is much smaller; and is a little smaller,
er, and longer in proportion to its width than the common
e fly. The legs are long, and the large compound eyes are
inent, covering much of the head. In front of and be-
n the eyes project the two two-jointed "feelers" or anten-
and projecting from the lower side is the proboscis or organ
gh which the blood of the victim is sucked. The posterior
of the body, called the abdomen, is small and covered with
.

ese flies light upon various parts of the cow's body—es-
lly over the shoulders out of reach of the tail—work their

Digitized by Google

There is another species of flea-beetle that frequently vegetables—especially cabbages, turnips, radishes an related plants. It is commonly called the Striped Flea- It is represented magnified at Fig.3, *b*, and is a small, black beetle, one-tenth of an inch long, with a broad, wavy, longitudinal stripe on each wing-cover. It feed the surface of the leaf, gnawing out little pits. The females deposit their minute, oval, whitish eggs upon the roots of various cruciferous plants, such as radish, cabbage, turnip, etc., and the larvæ which hatch from them feed upon these roots, sometimes doing serious damage in this way. The full-grown larva (Fig. 2, *a*) is about one-fourth of an inch long, with a yellowish-white body and brown head. There appear to be two or more broo season.

Fig. 2. Wavy-striped Fle *a*, larva; *b*, beetle. Ma

REMEDIES

A large number of substances have been recomme preventives of flea-beetle attack, success in the use of which depends, to a great extent, upon the comparative dance of the insects. Our own experiments indicate t pests may be driven off from garden vegetables, in early by the liberal application of simple repellant and d substances like plaster, air-slaked lime, soot, and es tobacco powder, dusted on when the plants are wet with

I obtained more satisfactory results, however, by the a spray of lime wash made by adding a pint or more of slaked lime to two gallons of water, and then thorough ing in about half a teaspoonful of Paris green. I spra upon a variety of garden crops with excellent results lime dries on in a firmer coating than when simply dus and consequently is more effective.

A still more certain remedy is found in the use of t

* *Phyllotreta vittata.*

Digitized by Google

mixture. The importance of this fungicide for this
se appears first to have been fully demonstrated by Pro
L. R. Jones of the Vermont Experiment Station. Our
ments this season corroborate his results.

mulas for the Bordeaux mixture have frequently been
hed, but even yet this valuable fungicide is not so largely
s it deserves to be. An extended discussion of methods
paring it will be found in Bulletin 27 of this Station. In

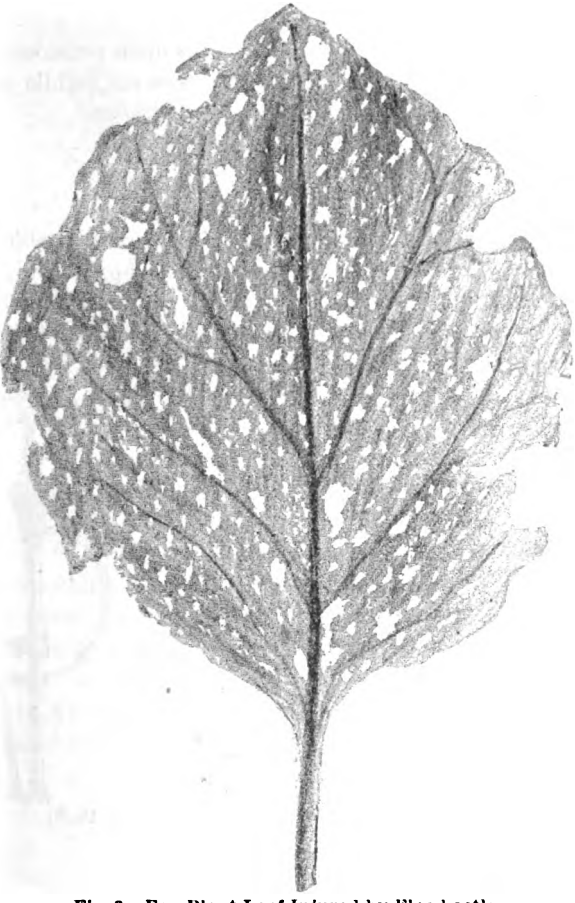


Fig. 3. Egg Plant Leaf Injured by Flea-beetle.

Digitized by Google

brief, it may be made as follows: Dissolve 5 pounds of copper sulphate (blue vitriol) in 2 or 3 gallons of hot water, in an earthern or wooden vessel. Pour into a barrel or tank, holding 50 gallons, and add water enough nearly to fill it. Now slake 5 pounds of good, *fresh* lime in 2 or 3 gallons of water and pour into the barrel, straining through a sieve as it goes in. Mix the two thoroughly and the preparation is ready. In applying for flea-beetles or to any crop which is liable to injury by insects add 4 ounces of Paris green to each 50 gallons of Bordeaux mixture.

The second brood of flea-beetles appears upon potatoes during the last half of July, so that spraying about the middle of the month is likely to protect the plants from attacks.

METHODS OF APPLICATION

The Bordeaux mixture or lime and Paris green combination, to be used to advantage, must be sprayed upon the plants. There are many sorts of spray pumps now upon the market so that they are adapted to almost any conditions.

The simplest way of spraying low-growing plants, when only a comparatively small amount of it is to be done, is to use a small hand force pump in connection with a pail or bucket. There are many styles of these upon the market; one of the best, which I have used for some time in my own garden is shown in Fig. 4. These hand pumps range in price from $3.00 to $6.00 and are useful for many kinds of work.

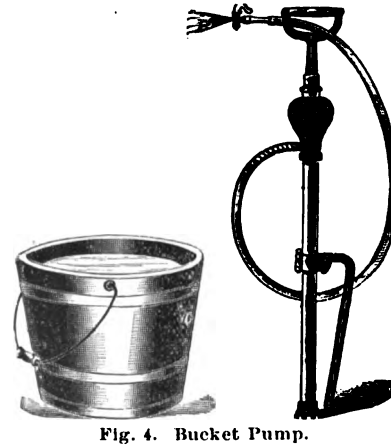


Fig. 4. Bucket Pump.

A very convenient spraying outfit for use in the garden and

Digitized by Google

home grounds is illustrated in Fig. 5. It is a home-made

Fig. 5. A Garden Sprayer.

easily gotten up by any one handy with tools. The idea outfit originated with Prof. L. H. Bailey.

knapsack spraying pumps 6) are handier for use garden than the bucket , but cost considerably As will be seen from ure the tank is strapped operator's back leaving ree to pump with one nd manipulate the nozzle he other. Using a knap- prayer is hard work, how- and is not advisable barrel outfits drawn by a an as well be used.

Fig. 6. The Knapsack Sprayer.

Digitized by Google

Digitized by Google

Sci 16 36.35

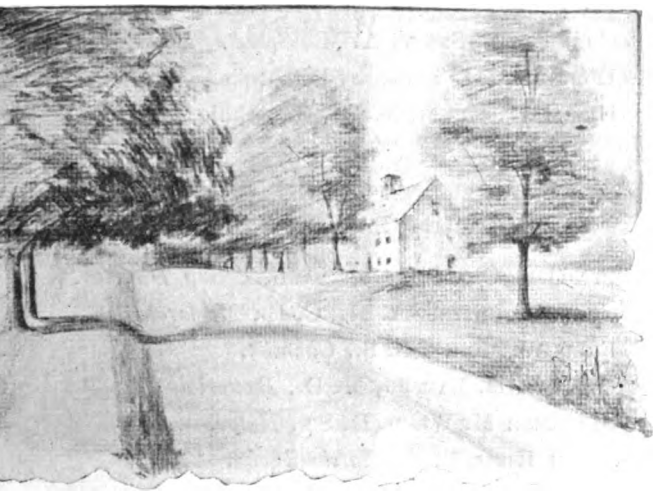
letin 30 July, 1895

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

AN EXPERIMENT IN ROADMAKING

BY CHARLES H. PETTEE



NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1936

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATIO

DURHAM, N. H.

BOARD OF CONTROL

Hon. GEO. A. WASON, *Chairman*, New Boston.
Pres. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover
Hon. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

President CHAS. S. MURKLAND, *Acting Director.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
LEIGH HUNT, B. S., *Horticulturist.*

ASSISTANTS

EDWARD P. STONE, B. S., *Assistant Chemist.*
FRED D. FULLER, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent to any resident of New Hamp upon application.

Digitized by Google

EXPERIMENT WITH A COUNTRY ROAD

BY CHARLES H. PETTEE

The making of a macadamized road is not in itself an experiment. Reducing the grade or rounding up the centre of a road-bed so as to give more permanency to the road itself is not new. Even, however, broken stone roads in a state are practically confined to city limits; when attention to grade is the rare exception on our country roads and correct form of surface is the exception rather than the rule, it seems to be time to institute such experiments, noting cost and results, as will determine whether the so called correct principles of road construction practiced in the larger centers of population are applicable to rural districts.

Advantage has been taken of the necessity of straightening and otherwise repairing certain portions of the highway adjacent to the college farm to carry out an experiment in road construction for the benefit of the farmers of New Hampshire who must and of necessity will continue to be the road builders in our country towns. Work was begun July 1, 1895.

LOCATION

A portion of the 1st New Hampshire turnpike between the Experiment Station building and the railway station, commencing 18 feet westerly along the turnpike from station 1 (a bound thus designated in college survey of village of Durham), thence extending 300 feet easterly toward the railway station, was selected for the work.

The following conditions controlled the choice. The location is partly on a hill with a grade of one-fourteenth, or one foot rise to every fourteen in length, and thus needed to be reduced in grade. Toward the top it was well drained with only a thin soil over ledge. At the foot of the slope was a heavy,

Digitized by Google

wet soil, underlaid with ledge, which had been more
graveled but which was always muddy in the spring.
surface was hollowing with the water running in the ce
the road. The location was central with reference to
property and needed improvement. At this point wat
the college reservoir was available for sprinkling.

SURVEY

As the bounds of the road were not well defined at this
the general course of centre line was noted for several h
feet either side of the portion selected and a more or les

PLATE 1.—Cross-section of Road.

plete survey was made for 400 feet as follows: Ten a
half feet were laid off either side of the centre line and
three feet in length, were firmly driven opposite each
every twenty-five feet on these side lines. Levels were
in the centre of the road between each pair of side stak
also at side stakes themselves. The results were plotte
cross section paper and suitable grades established
twentieth being the maximum allowable. The computed
of the several stations were then transferred to the side
and plainly marked thereon by horizontal lines. A
twenty-one feet in length connecting the marks on two o
side stakes would then at any time indicate the proper
of road bed at centre. As the string could be repla
pleasure it caused no inconvenience during the construct

Commencing at the westerly end four grades were estab
level for 25 feet; grade of one-twentieth for 125 fe
one-fiftieth for 75 feet; level for remaining distance.
1 shows the cross section of completed road,—slope from
to sides being one-fifteenth.

Digitized by Google

PLATE 2.—Foundation of Road. (From photograph.)

Digitized by Google

Digitized by Google

EXPERIMENTAL PLOTS

Four inches of gravel were placed upon the surface of two plots, e extending 62½ feet at the westerly end and the other 112½ et at easterly end; 125 feet of the middle were macadamized covered with a layer of broken stone to a depth of five ches after rolling. Of this 125 feet, twenty-five, commencing west end, had gravel foundation. The next 62½ feet had a ck foundation divided as follows: The south half was laid th flattish stone eight to ten inches deep, set on larger end, d securely wedged together by smaller stone driven into the aces between. The north half required an average fill of out one and one-third feet and larger stone were used there, ing packed together as closely as possible and spaces between ed with smaller stone and gravel. Plate 2 shows how these one appeared before they were covered in. The smaller dged stone of the south half of the road, forming a regular lford foundation, had already been covered and do not show the illustration.

Easterly from the stone foundation, for twenty-five feet in ngth, the south half was built up with some six inches of avel foundation while the north half was raised an average ten inches by clay overlaid with two inches of gravel. The t twelve and one-half feet of macadamized road were graded om three to twelve inches in depth with clay and the broken one was placed directly on this foundation. The hardened rface was what is called light macadam, consisting of a layer broken stone from one and one-fourth to two and one-half ches largest dimension, three and one-half inches in depth, ll rolled, followed by a layer from one-half to one and one-arter inches in diameter, two inches in depth, also well led. As the amount of stone dust available for surfacing s limited, a layer of good packing gravel one-half inch in pth was then added, followed by a layer of stone dust nearly e-half inch in depth and both were thoroughly rolled. During rollings the surface was kept well sprinkled.

The crushed stone for this experiment was given by the assachusetts Broken Stone Co. of 235 Franklin street, Bos-n, Mass., and was from their quarries at Salem, Mass., the

Digitized by Google

only cost to the college being the freight on the sa
table of cost, however, the regular price of the stone
inserted. This stone ranks high according to the tes
by the Massachusetts Road Commission and many ci
complete crushing plants buy it for surfacing and even
cases, for all purposes.

The roller used was owned by the city of Dover, N
is of stone and weighs 3700 pounds. It was kindly lo
the purpose of the experiment by Mr. Isaac L. Lucas,
tendent of Streets.

Of the graveled portion 62½ feet at the west
12½ feet east from macadamized part were graded
with gravel drawn a distance of a little less than
while the remaining 100 feet were surfaced with the sa
terial. The grade for foundation of this last 100
excavated from the side of the road. To drain the ea
ditch was dug along the south side for a distance of
with an average depth of three and one-half feet below
surface at centre. A three inch tile was laid and t
filled to within six inches of the surface with small st
being taken to protect the tile from crushing. The
was covered in with gravelly loam excavated from
ditches. To secure an outlet, a larger bell pipe was la
the road extending a total distance of 81 feet. To
suitable depth of ditch five charges of dynamite were
and considerable rock was removed by wedges. No
on the north side was considered necessary.

The following table gives the details of each separa
the work. Team work has been reckoned at $3.50 per
day labor, $1.50. Supervision has been estimated on
taking a suitable number of men and teams and d
work. On account of pressure of farm business th
work was spread over a longer period than supervisio

Digitized by Google

PLATE 3.—Road in Process of Construction. (From photograph.)

Digitized by Google

Digitized by Google

Grading 300 Feet of Road.

Cub. ds.	Material.	Length of Haul.	Cost Cub. Yd. Hauling.	Total Cost.
6	Clay.	1-6 mile.	27 cents.	$ 7.00
3	Gravel.	9-10 "	32 "	13 65
0	Hard Pan.	20 feet.	25 "	5.00
9	Rock.	25 rods.	29 "	14 25
or placing rock and spreading gravel.....				10.50
ervision and surveying three days at $2.00.....				6.00
				$ 56.40

pproximate cost of rock foundation laid, 44 cents cubic yard.

Surfacing 125 Feet of Road; Broken Stone Centre; Gravel Sides.

Cub. ds.	Material.	Length of Haul.	Cost Cub. Yd. Hauling.	Total Cost on Road.
3.1	Broken Stone.	18 rods.	26.4 cents.	$ 66.78
3	Gravel.	9-10 mile.	52 "	7.00
m getting roller and rolling, two days, at $3.50,.....				7.00
man spreading and sprinkling, two days, at $1.50.....				3 00
ervision three days, at $2.00,.....				6.00
				89.78

otal cost surfacing macadamized portion, 39 cents per square d.

otal cost surfacing macadamized portion if broken stone had n increased to 50 cubic yards would have been 59 cents per square d.

he cubic yard broken stone weighs 2500 lbs, or 1¼ tons.
.1 cubic yards = 41.4 tons; cost per ton at station $1.40; per cubic d $1.75.

Surfacing 175 Feet with Gravel, Four Inches in Depth.

Cub. ds.	Material.	Length of Haul.	Cost Cub. Yd, Hauling.	Total Cost.
42	Gravel	9-10 mile.	32 cents.	$ 13.40
ervision, one day, at $2.00,.....				2.00
				15.40

Ditching 160 Feet of Road.

Days Labor.	Work Done.	Av. Depth Feet.	Total Cost.
4.6	160 feet side ditch.	2½	$ 6.90
4.4	81 " main "	3	6.60
2	Rock in ditch.		3.00
amite,.....			.50
feet three inch drain tile,.....			2.40
" salt-glazed pipe,.....			6.48
ervision, two days, at $2.00,.....			4.00
			29.88
			$191.46

ost per running foot road surface, 63½ cents; per square yard, 27 cents.

Digitized by Google

Notes will be taken from time to time on the condition of t
different parts of the road that comparative results may
reported later. Meantime, as a result of this experiment and
careful observation of New Hampshire country roads throu
a series of years, the following remarks are appended:

1st, Cost. In considering results, especially cost per squa
yard, it must be borne in mind that all of the road under di
cussion required much more than average repairs in the way
grade and drainage, as well as surfacing. On the other han
with a less substantial foundation, the amount of broken sto
advisable on the 125 foot stretch would have been increased
some twenty tons, thus increasing the surfacing cost of th
portion by about twenty cents per square yard.

2nd, Permanent Work Necessary. The cost of this expe
ment is not presented as a model to be worked toward and n
excelled, but rather as the work of an amateur who is laborin
under the same disadvantages as would be found in the avera
farming town. It is evident that a policy of more or less pe
manent work every year would in an average period of t
years revolutionize the character of the roads of a town. A
could be given a proper rounded form; the main ones reduc
to standard grade, drained and fairly surfaced.

Experiments with macadamizing should by that time ha
made good headway and, with the need of ordinary repai
reduced one half by the proper construction outlined abov
the towns would be in condition to rapidly push forward t

Digitized by Google

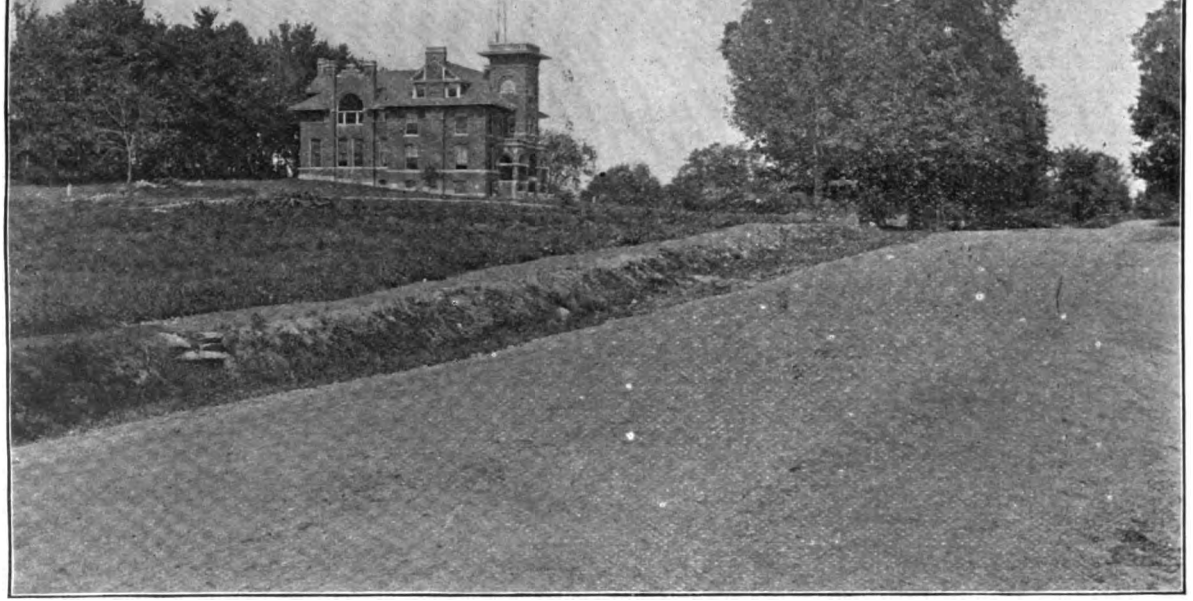


PLATE 4.—Completed Macadamized Road, with Experiment Station building in the background. (From photograph.)

Digitized by Google

Digitized by Google

amizing of all their main thoroughfares. All this is on pposition of no special effort; simply the proper use of generous appropriations, such as we are now accustomed e.

, *Necessary Apparatus.* The apparatus not usually in the sion of a country town, necessary for the construction of l road, either macadam or gravel, may be purchased for or less, and therefore is easily within the means of even a town. It consists essentially of a two ton horse roller, le of being weighted to three tons, cost about $200, and a er cart for sprinkling, cost about $350. For extensive amizing a steam roller is indispensible, but fair results e obtained without its use.

Grade Level. In reviewing the details of above ex- ent the only part which seems beyond the attainment of erage intelligent farmer is the survey. In the outlined this was made as simple as possible, no regular cross ns being taken such as would have been necessary for ct work. Still it is too technical for the average road r. To meet the difficulty I have devised a form of grade so simple that any carpenter can make one in a few hours f such utility that suitable grades may be selected and ut on side stakes previously placed at suitable distances necessarily equal distances as in the experiment) by any f good judgment with no figuring whatever. A carpen- evel, which may be obtained at any hardware store for a ; a straight edge pine board; eight carriage bolts with nuts for two of them; a few pieces of hard wood for and clamp are all the material required.

en no record is required to be kept work may be laid out his much more expeditiously than with a level even when ed by an experienced surveyor. In ordinary road repairs nvaluable as an aid to the eye, and even about the farm it e found of frequent utility as in drainage, laying water plumbing walls, etc. Plate 5 gives both plan and eleva- with all necessary dimensions. Grades of one-fiftieth, hirtieth, one-twenty-fifth, one-twentieth, one-eighteenth, fteenth, one-twelfth, one-tenth, one-ninth, one-eighth,

Digitized by Google

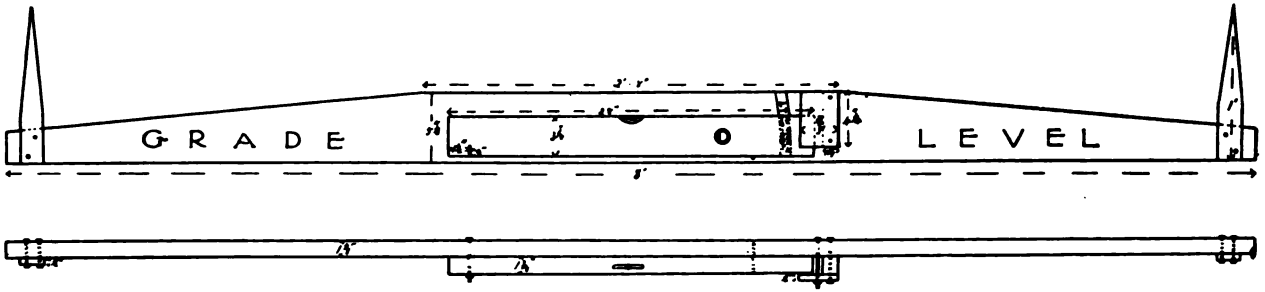


PLATE 5.—Design for Grade Level; elevation above; plan below.

Digitized by Google

e-seventh, one-sixth are indicated and others may be inter-
ated. The grade is read from the under side of the level.
graduate the board place level in position. Hold a pencil
nly against under side of level about two feet out from piv-
d end. Swing level, allowing pencil to mark arc of circle
board. Repeat operation holding pencil about three-fourths
h farther out on level. These arcs will form limits for the
duction marks. Remove level. Lay off accurately two
t, from centre of bolt hole about which level turns, along
board parallel to edge. At this point draw perpendicular
e upwards. On this line lay off proper distances for grades
ired. For example for grade of one-tenth the distance
uld be one-tenth of two feet or two and four-tenths inches,
one-sixth it would be one-sixth of two feet or four inches,
. Connect each of these points with centre by lines and
e by marks where these lines cross one of the arcs above
ntioned. Finally advance each of these marks downward
ng the arc the distance, say one-half inch, that the bolt hole
ough the level is above the base of the level. Now replace
el and bring base of same in turn to each of the marks as
ve determined and mark along the base of the level between
two arcs with a soft lead pencil. Carefully remove all
rks except the arcs and the final lines drawn across them.
ce on each line the fraction indicating its grade. Two coats
shellac will complete the work. Further information about
s grade level may be obtained of the writer.

5th, Road Construction. The four important points to be
sidered in constructing or reconstructing roads are as fol-
s: grade, drainage, proper form of road foundation, sur-
ing. They should be considered in the order named. In
mmon practice this order is reversed. Hence the necessity
doing over a great deal of work.

A few words on each of these points.

(*a*) Grade. Systematic efforts to reduce grades are rarely
de outside of city limits. In Europe no expense is spared
n among the mountains to reduce grades to at least one-
ntieth. While this limit is beyond us at present, no year
uld be allowed to pass without the reduction in grade of

Digitized by Google

some hills in each town. Neither should work of this sort considered complete till the standard grade is attained. T grade level will easily and accurately determine the chan that are necessary and will give data for preliminary estima of cost of this improvement. Such work should never be und taken till a complete plan for reduction to standard grade been adopted. Otherwise much labor may be wasted.

(*b*) Drainage. No permanently good road surface ex without suitable drainage. Fortunately most of our roads well drained by nature. When not so drained, if sufficient cannot be obtained, the road surface must be raised sufficie to insure the desired result. This is expensive and should avoided if practicable. Side drains, such as are described the experiment, are usually effective. If ground conts springs, these must be directly tapped by the side drains. S ditches must be kept open and clear.

(*c*) Foundation. The proper form of foundation of a r is seen in Plate 1, though it may be varied somewhat detail. This form should be obtained as far as possible by use of material near at hand. The road machine is indispe ble for much of this work. The poorest material, if well c ered in and drained, will make a good foundation for a co try road. It will *not* make the surface. The experiment sh that rock fill, however near at hand, is expensive unless ea loaded and simply dumped in place. If rock foundatio necessary to secure drainage, this extra cost will usually pr a wise expenditure. Do not make the traveled way too row. This is, perhaps, the most common, though not ne sary, defect of road machine construction.

(*d*) Surfacing. After forming a road it generally n surfacing. It is not, as is usually considered, complete w out. For this surface macadamize as rapidly as possi otherwise clay or gravel a sandy road; gravel a clay road. any case draw on some fresh material, not already worn that will pack with the surface and with travel. Use a sprin and roller. Otherwise surface late in the fall or earl spring.

6th, *Repairs*. Improvements in grade, drainage and for

Digitized by Google

l foundation should be permanent; once attained, to be
. Surfacing is too costly to employ much before these
r details are attended to. The best off-hand method of
ging the work of a highway agent is by the amount of
nanent work done and discrimination used in surfacing;
is, surfacing only where work will stand a reasonable
e.

Ien should be employed in each section of a town to make
necessary, ordinary repairs in surfacing, not once or twice
ear, but as they are needed. Nothing is so costly as al-
ng a good road to go to pieces for lack of a little attention.

h Records. More complete records, than are customary,
ork done by highway agents should be kept for the towns.
etailed statement of payments to John Smith, Henry Jones,
, is not sufficient. If a bridge is planked, a culvert relaid,
feet of road graveled two inches deep, 1000 feet rounded
with the road machine, and so on, these items should be
rted with at least approximate cost of each.

Digitized by Google

Digitized by Google

The Farm Houses
University of Nebraska
Sci 1636.35

lletin 31 November, 1895

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

SEVENTH ANNUAL REPORT

BY CHARLES S. MURKLAND

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATIO

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

PRESIDENT CHAS. S. MURKLAND, A. M., Ph. D., *Acting Direc*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horti*
turist.
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
FRED W. MORSE, B. S., *Chemist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent to any resident of New Hamps
upon application.

Digitized by Google

SEVENTH ANNUAL REPORT

The financial report of the New Hampshire College Agricul-
al Experiment Station covers the year ending June 30, 1895.
The summary of the work done is not necessarily circum-
ibed by the limits of the fiscal year. It must have some ref-
nce to the time when each annual report is published.

The act of congress, establishing agricultural experiment
tions, declares that "it shall be the duty of each of said sta-
ns annually, on or before the first day of February, to make
the governor of the state in which it is located, a full and
ailed report of its operations, including a statement of its
eipts and expenditures, a copy of which report shall be sent
each of said stations, to the said commissioner of agriculture,
l to the secretary of the treasury of the United States."

For some years it has been our custom to publish the report
the experiment station, together with the other college re-
ts, in one volume. This annual college report was dated,
accordance with the provisions of a state law, November 1.
The act passed at the legislature of New Hampshire at its
t session, decreeing that our college reports should here-
er be published biennially, has not greatly affected the case.
in the past, so now, the financial report must cover the year
m July 1 to June 30. The report of the station, as a depart-
nt of the college, must be filed with the secretary of state on
before November 1, of every other year; and on or before
bruary 1 of each year the report of the station must be made
the governor of the state.

The financial statement will be found immediately following
s introduction:

The last annual report, being delayed by various causes, in-
ded Bulletins 24 and 25, dated respectively February and
rch, 1895. Beginning with Bulletin 26, published in March,
95, the station has issued:—

Digitized by Google

When the latter are reached, each caterpillar begins fee upon the succulent green portions of the leaf. The young erpillars are about one-sixth of an inch long, and thickly ered on the back and sides with dark brown hairs. At the of a week the larvae, as these caterpillars are often called, their skins, crawling out clothed in a new covering previc formed beneath the old one. They continue feeding soon this first molt, and a week or two later again shed their s to provide for their increase in size. After another perio feeding a third molt takes place; the caterpillars have by time become about an inch long, and are handsome creatu

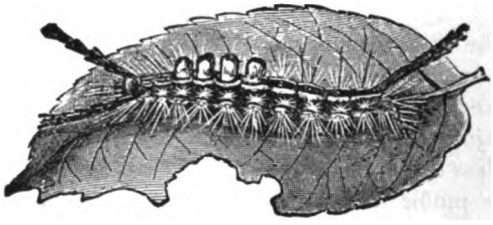


Fig. 1.—Caterpillar of Tussock Moth. (After Riley.)

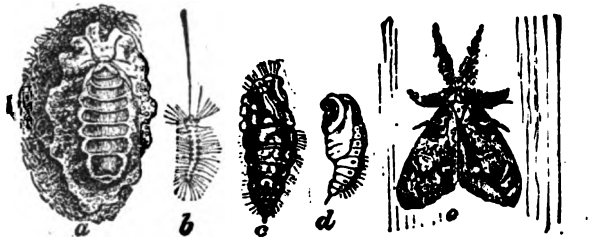
The general color is yellow: the head and two tube like projections on the hinder portion of the back are bi coral red; there are four cream colored tufts of hair along back. Two long black plumes project forward from just hind the sides of the head, and another projects backward the posterior end of the body. Along each side of the there runs a distinct yellow line; and lower down the there is another yellow line, generally less distinct.

About a week after the third molt a large proportion of caterpillars desert the leaves and seek the rough bark of trunk, where they spin loose, brownish, silken cocoons, w which they transform to the pupa or chrysalis stage. T are the caterpillars which are to develop into male moths. other caterpillars remain upon the leaves, feeding freely undergoing one or two additional molts as larvæ before spin cocoons. They finally spin up, however, in situations simil those selected by the males and change into brown chrysa When full grown they are much larger than were the

Digitized by Google

eveloped male caterpillars, and the chrysalids of the females re also much larger. (Fig. 2, *c*.)

About a fortnight after the caterpillars pupate they again ransform and emerge as moths. The two sexes of these differ reatly: the males (Fig. 2*e*) have wings, well developed feathery ntennæ, and the front legs thickly furnished with hair. "The eneral color is ashy-gray, the front wings being crossed by un- ulated bands of darker shade, with two black markings on the uter edge near the tip, and a white spot on the inner edge, lso near the tip. He may frequently be seen sitting on the runks of trees, or on the shady side of houses, etc., as he rests uring the day, and flies only after dusk, often being attracted y light The female (Fig. 2*a*) is totally different from the



g. 2—White-marked Tussock-moth: *a*, female moth on cocoon; *b*, young larva hanging by thread; *c*, female pupa; *d*, male pupa; *e*, male moth.

ale in appearance and resembles a hairy worm rather than a oth, since she possesses the merest rudiments of wings. She of a pale gray color, the antennæ being short and not eathered, the legs rather slender and not covered with long airs." (*Riley.*) In consequence of her wingless condition he female cannot fly; after emerging from the chrysalis she rawls upon the top of the cocoon where, after mating with the ale, she deposits her eggs in a single mass, and soon after ies.

NUMBER OF BROODS

In New England as a rule there appears to be but one brood year of the Tussock-moth Caterpillars. These mature about id-summer, spin cocoons and become moths late in July or rly in August. The eggs are at once deposited, to remain nhatched until the following spring. Further south there are vo broods.

CABOT SCIENCE LIBRARY

Digitized by Google

NATURAL ENEMIES

Fortunately this insect is attacked by a number of paras that help greatly in checking its increase. A careful stud the infested elms in Manchester, made by the writer in Aug showed that at least ten per cent. of the caterpillars had b killed by parasites. This is a hopeful sign for the future, it shows that if the people will do their part in cleaning off egg cases, the parasites will help to destroy those that esc But the parasites are not sufficiently numerous for the pu to leave the work entirely to them.

REMEDIES

The simplest and most effectual method of checking injury of this insect is to pick off and destroy the egg ma during autumn, winter, or spring. There is a long perio which the insect is open to attack by this method; and if owners of trees generally would employ it, there would be tle trouble from the pest. In New Hampshire it app advisable not to collect the egg masses until October November, in order to permit the useful parasites to ma and escape. It is a simple matter to collect the egg masse the lower portions of the trunks, but higher up and on larger branches they are more difficult to reach. But by m of ladders, or climbing irons, or agile boys, the difficulty be overcome. After the masses are collected, they may rea be burned.

At the time indicated it is necessary to collect only th cocoons which have egg masses upon them. Other coc are empty or contain parasites.

These insects may also be destroyed by spraying the t early in summer, after the caterpillars have hatched, Paris green in water, at the rate of four or five ounces of po to fifty gallons of water. Directions for spraying have b given in previous publications of this station. For shade t attacked only by Tussock caterpillars, the method of coll ing the eggs is believed to be preferable to spraying.

Digitized by Google

II. THE SUGAR MAPLE BORER

From Concord, Hanover, and other places in the central region of the state, there has been considerable complaint regarding a borer in maple trees. Affected trees looked unhealthy, having yellowed foliage and little of it; after midsummer the bark of the trunks showed holes as large around as a lead-pencil. The injury was easily identified as that of the insect long known as the Sugar Maple Borer.* This is no new enemy to the maples of this state; in 1828, Rev. L. W. Leonard of Keene, New Hampshire, studied the insect and gave the first account of its life-history to Dr. T. W. Harris, the author of the classic Insects Injurious to Vegetation. Since that time it appears to have been present throughout most of New England to a greater or less extent.

The adult or perfect insect of this maple borer is a large and handsome beetle, of the shape and size represented in Fig. 3. It is about an inch long, with a rounded body and rather long feelers or antennæ. "The head," writes Dr. Harris, "is yel-

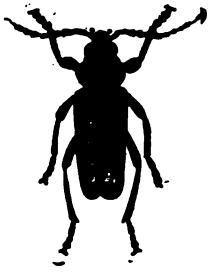


Fig. 3. Beetle of Maple Borer. (After Saunders).

low with the antennæ and the eyes reddish-black; the thorax is black, with two transverse yellow spots on each side; the wing covers for about two-thirds of their length are black; the remaining third is yellow, and they are ornamented with bands and spots arranged in the following manner: a yellow spot on each shoulder, a broad, yellow, curved band or arch, of which the yellow scutel forms the keystone on the base of the wing-covers; behind this is a zig-zag yellow band, forming the letter

* *Glycobius speciosus.*

Digitized by Google

W, across the middle another yellow band arching backwards, and on the yellow tip a black, curved band and spot; the legs are yellow; and the under side of the body is reddish-yellow, variegated with brown."

These beetles come forth from their burrows in the tree during July and August. During the latter month they lay eggs in the bark of sugar maples, selecting almost any part of the trunk for this purpose. In a short time—perhaps a week—these eggs hatch into small larvæ or grubs that burrow obliquely upward through the bark; their progress is slow, and more

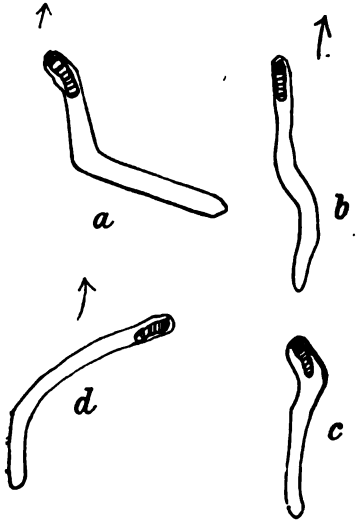


Fig. 4. Mines of young Maple Borers. (After Packard).

or less "frass" or castings are thrown out of the outer hole as they proceed. On this account the location of the little borers can generally be determined by looking the trees over carefully. The larvæ do not get beyond the bark the first autumn, and remain in their shallow burrows until the following spring. Then they burrow deeper into the solid wood of the tree, which thereafter they mine in all directions, the burrows growing larger as the insect increases in size. Finally

Digitized by Google

the grub becomes full grown in this larval stage; it is now a large, white, legless creature, with the body composed of many distinct rings or segments. It makes a cell near the outer part of the tree in which it changes to the pupa or chrysalis state; and finally again changes into an adult beetle, which comes forth in July and August to continue the propagation of the species.

This insect appears to confine its injuries to the sugar maple (*Acer saccharinum*), apparently, seldom, if ever, attacking the red maple. Further observations upon this point, however, are desirable.

REMEDIES

As already indicated, the entrance of these borers is generally shown by the brownish, saw-dust like castings thrown out of the hole, and the larvæ remain in the shallow bark from September until the following spring. Consequently they can easily be cut out with a sharp knife, during autumn, winter, or spring, with little or no injury to the tree. This appears to be the most practical method of destroying them. Of course the beetles and older larvæ should be killed when found, and maple trees so seriously injured by this insect or from other causes as to show evident signs of dying should be cut down and converted into firewood,—the wood to be burned before summer so that the larvæ present shall not mature,—rather than be left standing to serve as breeding grounds for the pests.

Digitized by Google

Digitized by Google

CABOT SCIENCE LIBRARY

Digitized by Google

Digitized by Google

Sci 1636.38

Bulletin 34 April, 1896

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

SURFACE AND SUB-IRRIGATION

OUT OF DOORS

IRRIGATED GARDEN

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

CABOT SCIENCE LIBRARY

Digitized by Google

JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STAT

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HENRY W. KEYES, A. M., Haverhill.

THE STATION COUNCIL

PRESIDENT CHAS. S. MURKLAND, A. M., Ph. D., *Acting*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and turist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. SC., *Entomologist.*

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
RUEL S. ALDEN, B. S., *Farm Superintendent.*
RICHARD FITZGERALD, *Clerk.*

The Bulletins of this Station are sent free to any resident of New H upon application.

Digitized by Google

HORTICULTURAL DEPARTMENT

Bulletin No. 34.—Irrigation

CONTENTS

	PAGE.
Introductory	5
Why we Irrigate	6
Source of Water Supply	7
Practical Examples cited	8
Irrigation Reservoir, Fish-Pond, and Ice-Pond combined	10
Economy of Water	10
Experiments with and without water-tight bottoms, indoors	11
Experiments with Sub-Irrigation out of doors	12
A New Idea in Irrigation	13
Surface Irrigation	14
Sub-Irrigation	16
How to lay the Tiles in Sub-Irrigation	17
A New Method	19
Expense	22
Cultivation	24
Mulching	25
General Considerations	25
Literature	26
Acknowledgments	26
Summary Remarks	26

Digitized by Google

Digitized by Google

SURFACE- AND SUB-IRRIGATION OUT OF DOORS

F. WM. RANE, M. S.

After Bulletin No. 33 of the West Virginia Experiment Station, "Sub-Irrigation in the Greenhouse," was issued, September, 1893, numerous inquiries came from various states asking for details in regard to special points, and particularly as to whether we had any experience or suggestions as to its application out of doors.

In regard to the application of sub-irrigation to out-of-door crops, we were without adequate data. Experiments have been pursued since then, looking toward a solution of the questions unsolved; and now, while we do not claim to be able to throw all possible light on the subject, nevertheless we feel that the practical ideas gained from three years' study and experimentation may be of interest and value.

In publishing this bulletin at this time, the main object is to cover the subject of irrigation in so far as it is of importance to that section of the country lying for the most part east of the Mississippi river; and with reference to small rather than large areas. If, by trial, it is shown that irrigation pays upon our higher priced land, as that of the garden, orchard, etc., the question as to its application on larger areas and cheaper land will naturally solve itself. The conditions in the section named differ widely from those in the so-called arid regions of the West. This bulletin is concerned only with the conditions prevailing in our own neighborhood.

The question of irrigation in the East is of late becoming more and more important. The past few years have been especially dry during mid-season, and where artificial watering has not been available, the various crops have necessarily suffered. This drouth, however, has not been caused by a lack of

Digitized by Google

the usual precipitation, or rainfall, as is the case in regions, for meteorological records show that the tota has varied very little from year to year; but the cau whole trouble is the irregularity of the distribution This irregularity is attributed to various conditions, among them, perhaps, being the destruction of fore question now is: How can we best overcome these co Irrigation seems to be the only alternative; hence we for a remedy.

WHY DO WE IRRIGATE?

By irrigation we mean supplying vegetation with when natural causes are not sufficient to produce t desired. It is mechanical interference with nature fo results. Until comparatively recent years few peop the Mississippi were interested in this subject; the tion, or rain-fall, was comparatively regular, and one another was sufficient. The severe drouths, howev past few years, which have been so persistent, have many people, and demand a remedy. People in som have actually lost money, should their time be count value, in growing certain crops; and in most sect drouth has materially cut crops short and therefore th for it is almost as much work and expense to grow crop as it is a full one.

In the arid lands of the West where the evaporatio the precipitation, we easily see that irrigation must be to; but this is not true of the East. Although in ma we do not know the exact excess of precipitation over tion, nevertheless the former is necessarily greater; t the point, however, for what we desire to secure is distribution of rain-fall. In the years containing so dryest summers, meteorological records show us that age for the year is fully as great as in other years summer seasons have been ideal. Knowing these f deners, fruit-growers, and in a few cases farmers, are out remedies for themselves. It is not uncommo question after question in our horticultural papers information on this subject.

Digitized by Google

In many sections land is too expensive not to realize considerable profit from it, and excessive cropping is necessarily being resorted to. In a dry season it so happens that much capital is lying idle, and it is a profitable investment that provides for irrigation. We irrigate, therefore, because we are compelled to in order to secure the best conditions for raising crops in a dry season.

SOURCE OF WATER SUPPLY

This question we cannot go into in detail. Where one person can secure water from natural springs or reservoirs, the majority are dependent upon wind-mills, hydraulic rams, steam-pumps, drawing in tanks or barrels, etc. This question is not as important to the general public, we feel, as the economical means of using water when it is available. By a little ingenuity, on the part of our gardeners and agriculturists, more or less water can be stored for a dry time. If by some means enough can be retained from our wet seasons to be used on small areas, as, for instance, from one fourth of an acre to four acres, or even less, the results will indicate whether it can be made a profitable investment or not. It is always desirable to have a good pressure or fall, if possible, as, even in sub-irrigation in the greenhouse beds, if there is no pressure or force to the stream, not nearly so good results are secured in the same time. Where no pressure is present, however, the same results can be obtained by having a slight incline, and checking the flow at various points. This is accomplished by damming up, if the irrigating stream be open, or by obstructing the flow by means of tins slipped between the joints, if irrigating by means of tile, removing and replacing the tins as the case demands.

The extensive operations in the West are dependent in most instances on a stream with considerable force and volume. Many of the reservoirs in our more central and eastern states will be on a less extensive scale, unless they are situated so as to use the water-works of cities. They will have far less pressure; therefore the percolations will necessarily be more natural, and that water brought into contact with the soil nearer the surface will be the more available for the use of the

CABOT SCIENCE LIBRARY

Digitized by Google

plant, volume for volume. By using the tins alre
tioned, the water can be easily controlled.

In some places it is possible to dam up small strea
run dry in summer, but during the wet seasons, as in
and fall, carry a great volume of water. This would
paratively easy task in many sections of this state, an
in the more hilly sections. Recently, when visiting
setts throughout the Cape Cod cranberry section, I
voirs built on comparatively level land, which wat
areas in a short time; one in particular, that of M
Makepeace, an extensive cranberry grower, who, b

FIG. 2. VIEW OF COLLEGE RESERVOIR.

up a small stream with a strong dam about one hund
length, is able to flood, if necessary, upwards of one
acres. The water supply at the West Virginia Ag
Experiment Station gardens comes from natural spri
mountains, six miles distant, and the Morgantown
incurs only the expense of piping it to the consumer,
fall securing sufficient pressure.

Figure 2 shows our own college reservoir. When
tution was located here a few years ago, the water s
found to be inadequate, and a few acres of land were

Digitized by Google

ng on either side of a small brook, a short distance from the llege. A dam, three hundred feet long, eighteen feet deep, d ten feet wide, was constructed, the water piped to the col- ge grounds, and now we have an almost inexhaustible supply water at a cost of two thousand dollars, exclusive of piping. Professor Robinson, Horticulturist of the Maryland Agricul- ral College, told me of an instance where one man in his te built a wind-mill and large tank in the centre of his ten- re trucking farm, who claimed that because he was able to igate, he had realized over and above ordinary returns, ough in two years to more than pay for his additional equip-

FIG. 3. COLLEGE FLORICULTURAL GROUNDS. IRRIGATED.

ent. One of the most practical methods of irrigation is that Mr. S. S. Bailey, of East Paris, Michigan, an account of hich was given in *The Rural New Yorker*, February 9, 1895. small brook was checked by a dam eight rods long, six feet gh, and broad enough on top to drive a team, thus making a nd covering three-quarters of an acre. Mr. Bailey claims to able by proper husbanding to relieve from drouth from y to eighty acres, as well as to raise the maximum of the op. Under head of results in a dry season, he writes that the mparative results with sweet corn were as $10 is to $93, not king into account the extra fodder obtained. With field corn,

Digitized by Google

in 1894, more was raised on three acres of irrigated land th upon twenty not irrigated. Strawberries were "a wonder all who saw them"; cabbage plants made heads "too la to suit the groceryman to sell at retail." Irrigation allow double cropping; after the corn, the ground was given up to r which was sown during the last cultivation of the corn a which gave excellent green pasturage for cows and sheep u late in the season. Mr. Bailey says: "As now controlled a utilized for irrigation, at a low estimate, we consider it wo more to us than an investment of $5,000 at six per cent. ann interest."

I know of one instance where a farmer has taken advant of a natural spring, which comes out of a bank. By excav ing slightly and building a rough stone work about it, he sufficient water for his barn-yard stock, which drink from trough into which the overflow runs,—and for a small gard It also supplies ice for his own use. A unique method of i gation was called to my attention last summer by a lady w had devised it. It was nothing more than old eaves-trou extending from the house to the cucumber patch in the gard which carried the superfluous water of the kitchen to assist cucumbers.

These are but few instances; many more could be cit Two prominent farmers, whom I know, have each backed small streams for fish ponds in summer and for ice in wint In both cases these are at sufficient elevation to irrigate nea half their farms, should they enlarge their capacity; bu doubt if the farmers have ever thought of doing it.

ECONOMY OF WATER

The object of all systems of irrigation is to place water at service of the plants, and that system which does this m effectively, and at the same time is most economical, is best. With the flooding or furrow systems of irrigation i estimated to be a day's work for one man to irrigate from to five acres; and in order to prevent loss from evaporat this system demands excessive cultivation. Even then the l is great.

With the latest, or sub-irrigation, method, which has b

Digitized by Google

successful both in the greenhouse and out of doors during past few years, we have a system, which, as its name signi-, applies the water to vegetation from beneath through pipes l below the surface of the ground,* and, in case of out-of-r irrigation, at a depth beyond the reach of the plow†. e ground is watered by capillary attraction. These pipes used indefinitely from year to year. One of the advantages med for sub-irrigation over surface-irrigation is the econ-y of water. Some advocates say that it does better work h half the water, while others go so far as to state that it es from three fourths to nine tenths. In our own experi-e, as far as the greenhouse is concerned, when we have er-tight bottoms in the benches, there is no question as to its ing both water and time. But from experiments carried on ing the past two years, we have found that the percentage vater saved is greatly reduced when this system is applied out-of-door crops, and even to crops in the greenhouse where water-tight beds, or those practically so, are not used.

EXPERIMENTS IN GREENHOUSE

To test this point as to greenhouse beds, an experiment was ducted by myself during the season of 1893–'94, at the West ginia station. Two beds, each eight by fifty feet, were de, in each of which three rows of tile were placed equi-ant and running lengthwise of the bed. The conditions of h bed were similar except that one had a perfectly water-t bottom of matched flooring, while the other rested on the und. The soil, method of watering, etc., were the same. e ground upon which the bed rested was a reddish, hard , which had been unused until the soil was put in. It become very hard and dry from the heat in the house; in it made such a good walk that we did not cement it until egan to show wear. After watering a few times we noticed the moisture was not sufficient in the latter bed, and we e compelled to resort to surface-watering. However much

* Agr. Science, Vol. vii, page 383.
* West Virginia Expt. Station, Bulletin 33, Vol. 3.
* Ohio Station Bulletin, Vol. V., No. 6, page 101.
† American Gardening, Nov. 10, 1894.

Digitized by Google

water was used, capillary attraction was not sufficient; on t other hand it soaked through the clay and even moistened t hard, dry walks on either side. The bed containing the wat tight bottom worked perfectly from the first. This, therefo showed that it was not altogether the fault of the soil.

To prove the above further, we took a section in the cen of the bed on the ground, five feet in length and eight feet width,—the width of the bed. It was separated from the r of the bed by board partitions, at the bottom of which notch were cut to accommodate the three rows of tile. We remov an inch or two of the soil from the bottom of this section, placing it with cement. We also cemented the sides a around the notches in the partitions, thus making the b practically water-tight. This section was watered with t same flow of water as the rest of the bed, the only differer being that when the water was emitted into the soil, it cou not soak through the bottom. The result in every instan was that if sufficient water was applied for the cemented pa the remainder of the bed received very little.

On the other hand if enough water was poured in the ti for the two ends of the bed, the cemented portion became mu dy. It is evident that if the sub-irrigated beds contain a tig bottom the saving of water is very great; but with some s bottoms, a greater percentage of water is lost by soaking throu the ground than could possibly have gone off through evapo tion in surface irrigation.

EXPERIMENTS OUT OF DOORS

Knowing the results of this experiment in the greenhouse, a the good results reported from other sources with this system o of doors, we arranged our grounds for testing it. Realizing th celery is a crop that demands water on high land, we arrang to water it in rows in this method, the tiles to be placed a depth to be missed by the plow.

Good results were secured from this system from the gro ing plants, but the saving of water was not nearly as great claimed by other experimenters. On examination we found th as in the greenhouse bed without the water-tight bottom great quantity of water escaped deep in the soil and ran off

Digitized by Google

e drains, while the soil was not even moist for some distance low the surface. In our soil it was a hard matter to deter- ne what was the limit for beneficial results. The tiles being t of sight, it was difficult to tell whether they were distribut- g the water evenly; also there could be no doubt as to the travagance of this method with water.

A NEW IDEA

Realizing the defects of the above system and the demands a still more practical one, we studied the existing conditions

G. 4. THE METHOD OF IRRIGATING ON A LARGE SCALE IN THE WEST.

th the idea of improvement. The objection to surface irri- tion, then, is waste of water in evaporation, some horticul- ists claiming that in very hot weather five sixths goes off in e air; therefore, in order to get benefit of one sixth, we must ply five times as much more. Whether this is true or not, e do know that a great quantity of water is necessarily lost this method.

CABOT SCIENCE LIBRARY

Digitized by Google

In one of the late issues of a prominent horticultural p
the writer says, "In determining the depth at which th
should be laid, * * * at no place should the tiles l
near the surface, that they will be disturbed by the plow."
can see that this is true, perhaps, of some soils but it i
true in all cases.

Since we found that sub-irrigation could not be depe
upon as an economizer of water on account of seepage
since in surface irrigation there is a great loss of water thr
evaporation, we could see no reason why the use of the
could not combine the good points of both methods by pl
them near the surface. The objection to their being p
above the reach of the plow would be overcome by the fac
they could easily be removed, if necessary, when the crop
harvested. Accordingly, experiments to test this arrange
were carried on at the West Virginia Station the past two
with satisfactory results.

As this new method of irrigation contains all the comm
able points of both surface irrigation and sub-irrigation, I
it worthy of consideration. It approaches much nearer an
system for economizing water,—doing away with the grea
by evaporation in surface irrigation and by seepage in
irrigation. Also, since the tiles are above the greater m
the roots, the water that does soak away is at the comma
the plants.

SURFACE IRRIGATION

Where plenty of water is available we believe the bes
most satisfactory results are secured by applying the
where needed through ditches. The ditches are easily
quickly made with plow, cultivator, or hoe; they cost onl
time of making, are easily checked at any point, and the o
tions are under known and visible conditions. There
obstruction either below or above ground to hinder cu
tion; there are neither pipes nor tiles to be stopped or clo
by roots or foreign matter. While more or less evaporat
going on, this is easily overcome to a certain degree by
ciously cultivating and applying the water during the c
portions of the day or in the evening. What water does

Digitized by Google

the soil is available and effective, and, assuming that the ground is already well drained naturally or artificially, the conditions are the best. The shallow-rooted plants are always directly benefited, while the deep-rooted ones derive some good. They, however, are not always in as great need of moisture even in dry weather. Good results from surface irrigation also depend upon the surface soil; purer sandy soils are not retentive of moisture, while the stiff clays are particularly so; therefore soils such as the loams are much preferable.

Figure 3 and the frontispiece show sections of both floricultural and olericultural or vegetable gardens on the college grounds, which have been watered for the most part by surface irrigation. In Fig. 3 the average depth of soil was not over six inches on account of underlying ledge, but by proper fertilization and irrigation through a net-work of small ditches made and manipulated by Mr. Hunt, the assistant horticulturist, the beautiful effect here shown was accomplished. In the frontispiece, the conditions were about the same except that the soil was very much deeper. The outer rows, or the rows next the fence in this cut, show very plainly the effect of lack of irrigation. The lower ends of these rows together with the rest of the section were watered by surface irrigation. The furrows for the distribution of water were shaded by the foliage in both of the cuts and, too, at the time when the sun was hottest and the drouth severest, and evaporation was thus partially prevented.

There are many instances where surface irrigation will be found the most economical, not only where plenty of water is to be had, but where economy of water is necessary. There are more advantages in favor of this method than are attributed to it. After having experimented with sub-irrigation at various depths and upon different soils, I would recommend caution before going into irrigation on a very extensive scale, believing that the extra expense in purchasing and laying tiles will more than offset the expense of labor in surface irrigation. Figure 4 shows the method of surface irrigating or flooding in the West.

CABOT SCIENCE LIBRARY

Digitized by Google

SUB-IRRIGATION

Doubtless there are soils in which sub-irrigation—through pipes laid beneath the surface—would be mo mical than any other method of irrigation. Theo appeals to the mind as being an ideal system. One w " If properly carried out the system has many advan any of those using surface irrigation. Among the noted economy of water, as its advocates claim th better work with less than one half the amount while some go so far as to claim that it saves from th

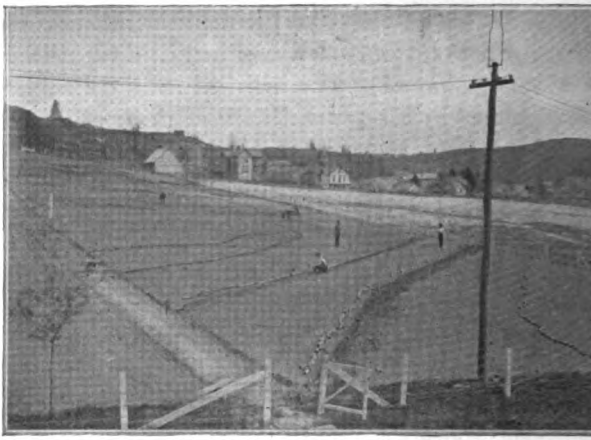


FIG. 5. LAYING TILES FOR IRRIGATION, W. VA. UNIV.

to nine tenths. When the flooding or furrow system tion is used it will be a day's work for one man to irr one to five acres, but with sub-irrigation he will m to turn on or shut off the water from the different port systems of tile, and while the irrigation is going on himself about other duties."

The misleading feature of this system of irrigati from the difference among the soils; hence, unless th has an experimental knowledge of his own condi chances of failure are great. A physical and m knowledge of the soil is necessary before one enters

Digitized by Google

erations. Some soils absorb and retain moisture readily hile others do not. Even in sub-irrigation in the greenhouse eds, where we have studied this subject most, we found that me soils although carefully prepared for the indoor beds, ere slow to absorb moisture through capillarity unless the eds in which they were placed were water-tight. Some green-ouse soils need watering daily; others, such as those of mucky nsistency, need it but rarely.

Where sub-irrigation will work well out of doors it is an eal method of watering. Some of the points in favor of it e as follows:

1. The surface soil never bakes or surface hardens.
2. Plants run very evenly.
3. The soil can be worked at any time and thus be kept in tter condition.
4. It is claimed that less water is required.
5. The pipes or tiles serve both to water the beds and retain e excess of moisture.
6. The openings underneath the soil allow free access of air; nce soil never becomes sour or stagnant.
7. Surface evaporation is slight.
8. Fungous diseases are not so prevalent.

LAYING THE TILES FOR SUB-IRRIGATION

Laying the tiles for sub-irrigation necessitates a knowledge many of the points already considered. On very rolling ound it is necessary to follow the contour of the slopes, giving e tiles a drop of about one inch in one hundred feet if in long ns, or if in shorter lengths a slighter grade (see Fig. 5). The stance between the rows of tile varies with the nature of the il and sub-soil, depth laid, and kind of crop to be grown. sually tiles are placed from 6½ to 40 feet apart, depending on whether they are to be used for the vegetable and flower rden or for the orchard and farm. The depth generally commended is from any distance below the reach of the plow two feet below the surface. When the proper excavations ve been made, the same methods are employed as in deter-ining the proper level for ordinary tile drainage. One must

Digitized by Google

understand just how to lay the tiles so that the ends may no
either too far apart or too close together, depending upon
slant of the tiles and the nature of the soil. An inexperien
person might better get an idea of this by first laying a
upon the surface and, by pouring water through it, study
action. Should there be danger of the tiles bursting from fr
ing during the winter a proper drainage should be give
certain points to draw the water off in the fall. By tak
advantage of this drainage the excessive moisture in the soi
spring, and after drenching rains, can also be drawn off.

The tiles can be so laid that the water is applied throug
single main feed-pipe; or, by running the pipes above gro
at the end next the hydrant, each row may be watered separat
The latter method requires a number of hydrants at conven
distances along the garden so that pieces of ordinary gar
hose will reach all lines of tile. In order to get the
results in the former case the ground should be nearly level.

Even then still better results are secured by having not
one half acre in each system, and a number of these syst
rather than one large one. The main feed-pipe should be
less than two inches in diameter for an acre of land w
applied through a single system. This should be enlarge
the area and number of systems increase. Where the prac
is to water a number of lines at the same time, a proportiona
larger supply pipe is needed. A one-inch pipe answers
areas not over one half acre, a two-inch for an acre, and a
portional volumetric increase as the area is enlarged.

The reservoir should have sufficient capacity to irrigate
area under consideration. In order to cover an acre of gro
to a depth of one inch, it requires 3,630 cubic feet of w
which is equivalent to about eight hundred and fifty barr
A similar quantity should be provided for sub-irrigation.
the ground becomes very dry, it is advisable as in surface i
gation to use the maximum quantity to get beneficial retu
If the surface is frequently cultivated, the loose soil preve
evaporation and hence lessens the number of applications i
dry time. By watering frequently rather than waiting until
the reserve water is needed, only a portion of it will
required and there will be a constant supply on hand; for a

Digitized by Google

case of a windmill, during the dryest time the wind does blow regularly even on the sea-coast.

A NEW METHOD OF IRRIGATION

An account of this was given by myself in *Garden and rest*, December 5, 1894, and again in *The Rural New rker*, June 1, 1895. The plan recommended was about as ows:

Try irrigation by simply placing the tiles slightly in the sur- e of the ground, or at any convenient depth; give them a ght incline, this varying according as you have pressure or . In most cases, the water is scarce, and the object is to it to the roots of the plants with as little waste as possible.

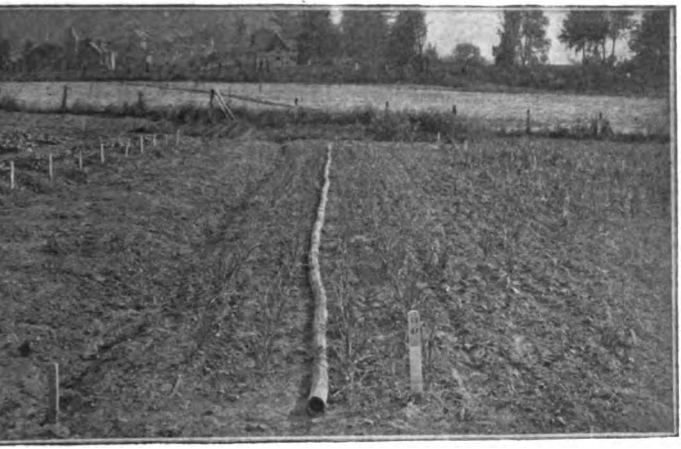


FIG. 6. ONIONS FROM SEED WITH AND WITHOUT IRRIGATION.

The plan followed by us last year was to place common, ous two and one-half inch drain tiles in a continuous row, to end, on the surface of the soil, and vegetables were nted on either or both sides of the line. The tiles were one long, and by pouring in the water at one end of the line was distributed at the joints throughout the length desired, en the opposite end was stopped up. Take celery as an mple crop for irrigation on uplands. We plant the celery above stated, Fig. 6, and while it is young we have simple

Digitized by Google

surface irrigation; but as the crop grows, we bank it finally have the tile covered, and thus have sub-irrigati 7. The tiles are cheap and last indefinitely. When t is harvested, the tiles are dug out also and piled up for sub-irrigation in the greenhouse beds. Potatoes ous other crops can be grown in the same way. T watered this year grew well, and did not rust. Bes we were able to water twenty times as much space in time as in the ordinary way with ditches. Besides sav this plan delivers water where it is most needed, and reason to believe, is fully as economical with wate time.

Rows of celery watered in this manner were pla potato field, leaving every other space between th rows vacant, so that two rows of potatoes could together when ripe. Besides watering the celery, th ure reached the tops of the potato hills, as was pla every morning by the dampness of the surface throug intervening space, thus showing that the watering v cient for at least three feet and three inches on eac six feet six inches in all, the rows being three feet thr apart. Where the rows were on a slight incline, we piece of tin between the joints, and held the water wh needed; then, by pulling it out and inserting it furth another section could be treated. The sections can longer or shorter, according to the angle at which th inclines. This subject is receiving our attention this we hope to be able to present it more fully at a future

As already stated the work was continued last ye West Virginia Station, and as is shown in Fig. 5 con area was used for testing this system. Last year, proved to be a very poor season for this purpose; sho the plants were set out, they were caught by a frost a a second transplanting was nipped, which rendered i in the season for natural conditions by the time the third came on. The season was exceptional also for the re the rainfall was comparatively well-distributed there, a fore little irrigation was needed. In the case of onions ground very fair results were shown in favor of those

Digitized by Google

Fig. 6 shows the comparative results where seed was sown upon upland,—with and without irrigation. As shown in the photograph, the row of tiles was simply laid upon the soil and used as a quick conveyance of the water to the soil, the water entering the upper end of the tile through ordinary garden hose con-

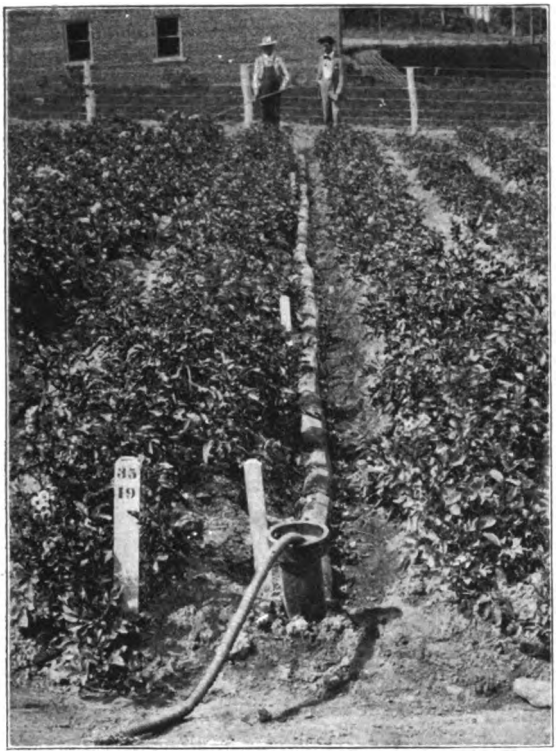


FIG. 7. IRRIGATING CELERY; THE BEGINNING.

nected with the hydrant. We found also that the tiles when laid lengthwise in the old-fashioned garden bed, where the rows run crosswise and comparatively close to each other, assisted greatly in rapid watering. Where celery is grown in beds for self-blanching the same method of watering is very advantageous.

CABOT SCIENCE LIBRARY

Digitized by Google

This system is a combination of both the sub-irrigation a surface irrigation systems and the points claimed are:

1. It is a great economizer of time in watering.
2. It saves water.
3. It applies water where the plant cannot but help rece ing benefit from it.
4. It is simple, practical, and inexpensive.

EXPENSE

This is the vital matter, and any system of irrigation will cline in use should it prove to be beyond the reach of the av age farmer. What is most desired at present is a system irrigation that will be efficient and at the same time inexp sive. The reason, doubtless, that more experiments have been carried on in the eastern United States is on account the great amount of time, labor, and money required to forth proposed plans,—with the uncertainty of beneficial turns. Where conditions do not favor the formation of a co pany for the erection of a reservoir sufficient for all, the indiv ual must irrigate to the best of his circumstances. For this r son surface irrigation by the furrow system is popular wh water is at hand, for many can give the great amount of la necessary but are unable to expend the money required for cement pipes, tiles, etc.

The cost of the reservoir or source of water supply will the same regardless of the method of application. It is portant that it be adequate for the area used, which for gene purposes is a minimum of eight hundred barrels per acre one good application in a dry time. If this amount can replenished by pumps, springs, etc., at frequent intervals reservoir of this capacity will be large enough, but should operator depend upon one general supply, a proportiona larger one will be needed. A wooden reservoir for any c siderable area would be quite expensive, and it will be c where good returns are depended upon from small areas t these are profitable. A 7,200 gallon reservoir at Durha made of cypress or Georgia pine, was built at a cost of nin dollars, which did not include connections and foundation.

Natural reservoirs can usually be made at less expense

Digitized by Google

e fully as durable. By puddling the bottoms and sides see-
ge can be prevented as well as by cementing, and the cost is
less. These reservoirs should be on the highest spot so that
light fall may be secured from it to all parts of the grounds.
ne cost necessarily varies in each instance; therefore I will
t attempt to give detailed expenses of reservoirs.

FIG. 8. IRRIGATING CELERY; TWO-THIRDS GROWN.

The cost of conveyance of the water from the reservoir to the
ound will vary as to the distance the water is to be carried as
ll as the method of conveyance. If through open ditches the
pense is simply in the amount of labor, which is only that
ployed in making the main ditch. This should be built
th the sides thrown up so as to bring the bottom on a level
th, or a little above, the surface where the water is applied.
ne size of the ditch must conform to the slope and amount of

Digitized by Google

water to be carried in it. Where pipes are used the cost v
vary according to their diameter and kind of material used.

The cost of the tiles and the expense of laying them for
tribution in sub-irrigation is said to vary from twenty-five
forty dollars per acre. Where they are laid near or on the s
face as described under head of "New System," the only
pense practically is that of the tiles, as the laying of them
very simple matter. The tiles, size two inches, cost ab
fifteen dollars per thousand, and the three-inch about twe
dollars. The expense of course is in proportion to the num
of tiles used. Test them on a small scale at first and find
whether you would be benefited by the extra expense. Sho
they prove a success more can be used; if a failure the tiles
always a good investment for drainage.

Cut 4 shows the method of surface irrigation. A slope of
inches in every one hundred feet is considered a good flow
furrow irrigation, while one foot to the hundred is about
much as one can handle.

CULTIVATION

To get the best results cultivation goes hand in hand w
irrigation. It is a necessity for plant growth; it not only ke
the weeds down but gives better ventilation, more sunlight,
reduces the amount of evaporation from the soil. Frequ
shallow cultivation, say once a week or thereabouts, reta
the moisture in the soil sufficiently many times to bridge o
short drouths. It should be begun as soon after a rain as
land can be worked. By deep plowing, which may mean s
plowing in some cases, together with the cultivation alre
mentioned for cultivated crops, and proper cultivation bef
planting with other field crops, the plants will withstand
comparatively severe drouth before demanding irrigati
The more one can counteract drouth by proper cultivati
therefore, the less the number of applications of artificial wa
ing. The only thing to be understood is that when artifi
watering is necessary to secure desired results, the sup
should be adequate, which means, as already stated, one ba
(thirty-two gallons) per tree, or five hundred to eight hund

Digitized by Google

barrels per acre. Stop cultivation when the proper time comes, which ordinarily is also the best time to stop irrigation.

MULCHING

This is nothing more than another kind of irrigation in a milder form. The mulch used retains moisture which in a dry time protects the ground from drying out so readily, thereby benefiting the plants. Mulched strawberries in the season of 1894 withstood the drouth while others died; also those unmulched and irrigated as well did not require as much water and gave better results than those irrigated and not mulched.

Tomatoes mulched in 1895 and not sprayed gave fully as heavy yield, accompanied by a far less amount of rot. The results from mulching depend more or less upon the season, but it is believed we can well afford to give it more attention, especially in our gardens.

GENERAL CONSIDERATIONS

In order to obtain a comprehensive knowledge of irrigation we must have a similar knowledge of drainage. There is evidently a close relation between the two, and just how elastic it is no one knows. There are many soils that perhaps would be more productive were they tile-drained instead of demanding artificial watering; others have a natural drainage and need more moisture, while still others would yield better returns with both drainage and irrigation provided. Soils differ in the absorption and retention of moisture. Water held in the soil by capillarity is better suited to supply the plant than free water which flows under the action of gravity. The main principle is that, whether naturally or artificially, enough water must be supplied, but not so much that it will stagnate and induce conditions unfavorable for plant growth.

The conditions for practical success in irrigation are as follows:

1. Reservoirs of good water, natural or artificial.
2. A sufficient descent from the reservoirs to the place of distribution; the more pressure, the better.
3. Proper soil.
4. Experience and good judgment in application.

CABOT SCIENCE LIBRARY

Digitized by Google

LITERATURE ON IRRIGATION

For general literature on this subject, see The Third A
Report of the Colorado Agricultural Experiment Sta
1890, pp. 78, 79, which gives a list of 71 works on irrig
with brief comments on the character and the scope of
also for statistics and cost of irrigation works, same report
71–78.

More or less has been done in other states, as for exa
California, Nebraska, Arizona, Utah, Wyoming, Louis
Wisconsin, Kansas, and New Jersey, reports of which m
found in the Experiment Station bulletins.

ACKNOWLEDGMENTS

Figures 7 and 8 were loaned me by Dr. J. A. M
Director of the West Virginia Experiment Station; als
photographs from which Figures 5 and 6 were made; Figu
from the Orange Judd Co.

SUMMARY REMARKS

1. We irrigate because we are compelled to in order
cure the best conditions for raising crops in a dry season.

2. Apply enough water when irrigating to do some goo
pailful applied now and then in a dry time is useless.

3. By being able to irrigate when a crop is nearly mat
we have a first-class crop, where otherwise would be an
ior one.

4. Ground beds in the forcing house, watered from the
row of tiles, with all conditions the same excepting that
of the bed had a water-tight bottom while the remainde
not, gave good results in the former case and very poor
latter.

5. Experiments with celery upon a clay loam, with
applied both through ditches for surface irrigation, and th
tiles below the reach of the plow for sub-irrigation, showe
the latter system required much more water than the f
for the same results.

6. By taking advantage of the cloudy portions of th

Digitized by Google

d as well the shade from the foliage of the plants, the loss m evaporation in surface irrigation is greatly lessened.

7. The percentage of water saved in sub-irrigation out of ors is greatly reduced on account of its soaking off in the soil ow.

8. The fact that the tiles are out of sight and their action known makes ordinary sub-irrigation a little uncertain.

9. Sub-irrigation out of doors, where it works well, is an al system of watering.

10. If possible have a good pressure or fall.

11. Experiments for two seasons have shown that when the s were placed near the surface of the ground, the plants fully as well as in the other systems and with less water.

12. By placing the tiles near the surface, the great loss by poration was overcome. This system also placed the water ere even the shallow-rooted plants could not fail to receive It also combined all the good points of deeper sub-irri- ion.

13. Three thousand six hundred and thirty cubic feet, or out eight hundred barrels, of water is the amount estimated cover one acre of ground to a depth of one inch,—the amount ommended per acre for reservoir capacity.

14. Onion seed sown upon upland, with and without irriga- n, gave marked results in favor of irrigation.

15. To get the best results cultivation goes hand in hand with gation.

16. Mulching and sub-soiling are milder forms of irrigation ich can be resorted to with good results to counteract drouth.

17. Many soils need drainage, perhaps, rather than irrigation, ile in some others there is a medium, which gives best ults.

18. Under existing climatic and meteorological conditions, gation solves a very discouraging problem.

Digitized by Google

Digitized by Google

Sci 1636.35

HARVARD COLLEGE
JUN 6 1930
LIBRARY

letin 35 May, 1896

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

IE CODLING MOTH AND THE APPLE MAGGOT

BY CLARENCE M. WEED

The two most destructive insects affecting the fruit of the le in New Hampshire are the Codling Moth or Apple rm and the Apple Maggot or Railroad Worm. These s greatly lessen the value of the apple crop in the state, are among the most important enemies of our agriculture. e first named insect—the Codling Moth—has apparently n about as injurious as at present during the last twenty rs, but the last named—the vexatious Railroad Worm—ndoubtedly increasing in destructiveness from year to year.

THE CODLING MOTH

Carpocapsa pomonella

For more than a century the Codling Moth has preyed upon fruit of American orchards, into which it was introduced n Europe early in our history. Its life-history, briefly sum-rized, is this: The parent insect is a small, chocolate brown h (Fig. 1, *g*), scarcely half an inch long, which appears ong the trees in spring about the time the apples are form-from the blossom. Here in the cavity at the upper end of upright fruit the female moth deposits an egg. In a short e this egg hatches into a small, whitish worm, which nibbles he skin of the young fruit, finally biting through and eating way to the core. Here it continues feeding as the apple

Digitized by Google

develops, gradually increasing in size until at the end of
or four weeks it is about three fourths of an inch long, a
the general form represented in Fig. 1, *e*. Having no

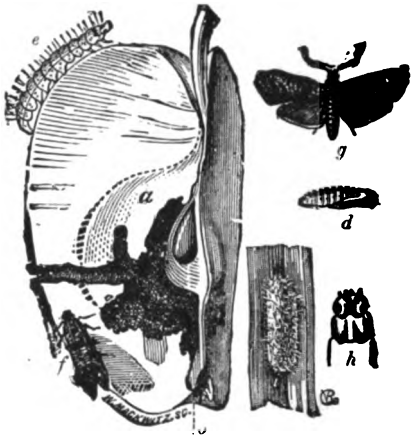


FIG. 1. Codling Moth: *a*, injured apple; *b*, place where egg is
larva; *d*, pupa; *i*, cocoon; *g*, *f*, moth; *h*, head of larva. (*After R*

ished its caterpillar growth, it leaves the apple and seeks
crevice in the bark, where it spins a rather slight silken co
in which it changes to the quiet pupa or chrysalis stat
this pupal condition it takes no food but the tissues
body undergo the wonderful transformation by whic
worm is changed to the moth. Two or three weeks aft
cocoon was made the insect comes out as a moth, like th
which laid the egg in the blossom end of the young
These moths commonly lay eggs for a second brood of w
that develop in the apples throughout the late summe
early autumn.

Experiments conducted at this Station during the last few
as well as the experience of thousands of orchardists throu
the United States have demonstrated that the injuries
Codling Moth may be prevented by spraying the trees with
green, mixed with water. By means of the spraying ma
the fruit grower is able to place in the blossom ends of the
apples a few particles of poison, so that when the newly-ha

Digitized by Google

rm nibbles at the skin, it is likely to eat one of these particles
l be killed. To accomplish this purpose the orchardist mixes
r or five ounces of Paris green in a barrel holding forty or
y gallons of water, and then having the barrel in a wagon, he
ves along the rows of trees, just after the blossoms have fallen
and sprays them by means of a force pump and spray nozzle.
e little particles of poison are thus distributed over the tree
a fine mist, and when the water in which they are suspended
porates, they are left high and dry upon the leaves and fruit,
ere under favorable conditions they remain for several weeks
nenace to insect enemies, until the combined action of rain
l dew, wind and sunshine, dissipates their poisonous pro-
ties. The first brood of worms being thus destroyed, the
elopment of the second brood is checked.

The spraying is done when the apples are from the size of a
to the size of a hickory nut. Two, and in case of very wet
ather three, applications are advisable. Paris green is almost
oluble in water, but there is often a small percentage of it
uble, and to prevent the injury this may do to foliage it is
isable to add a quart or two of fresh lime water, made by
king fresh lime in water, to each barrel of the spraying mix-
e. Or the Paris green may be used in combination with
Bordeaux mixture.

The philosophy of spraying for the Codling Moth rests upon
fact that the egg is laid upon the outside of the fruit, and
sequently the young worm has to nibble through the skin.

THE APPLE MAGGOT OR RAILROAD WORM

Trypeta pomonella

This is the most troublesome apple pest in the state, and as
eady intimated it is increasing in destructiveness from year to
r. The injury of this insect is at once distinguished from
t of the Codling Moth by the fact that while the latter is
gely confined to the region of the core, the Apple Maggot
ds indiscriminately through the pulp of the fruit, burrowing
every direction. The larvæ which do the damage are them-
ves also different, that of the Codling Moth having six legs
ile the Apple Maggot is footless.

Digitized by Google

The parent of the Apple Maggot is a two-winged fly appears early in summer and deposits eggs in the part grown apples. These eggs are inserted one in a place, thro the skin of the fruit. In a few days each hatches into a r

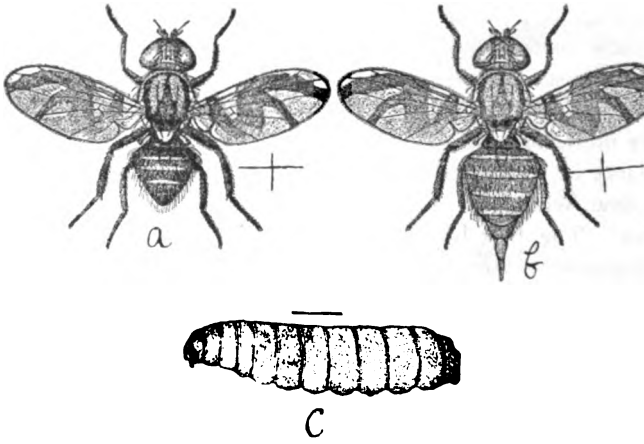


FIG. 2. The Apple Maggot or Railroad Worm: *a*, Fly, male; *b*, Fly, fe *c*, larva. Magnified. *(After Comstock and Harvey.)*

got that tunnels the fruit in all directions, becoming full-gr in five or six weeks, when it is whitish or greenish white, about a quarter of an inch long. The maggot then leaves apple and generally goes into the soil an inch or less whe changes to the pupa. The insects remain in this condi until the following summer, when they emerge as flies agai

The most careful observations upon the life-history of Railroad Worm have been made by Professor F. L. Harve the Maine State College. As the conditions in New Ha shire are practically the same as in Maine, I quote the foll ing account of the details of the insect's life-history writte Professor Harvey:

"In early seasons, under favorable conditions, the flie Maine begin to emerge about July 1, and earlier in the st farther south. They continue to emerge all summer and ar the wing in abundance until the middle or last of Septen and occasionally in October. Early frosts check them.

Digitized by Google

flies lived three weeks in confinement, and will probably live longer in nature. They begin to deposit their eggs in the early fruit by July 1, or earlier, and egg laying continues while the flies are on the wing, the earlier races of flies affecting the earlier varieties, and the later races the fall and winter fruit. Each female is capable of laying, at least, between three and four hundred eggs, which are inserted from time to time, one in a place, by means of a sharp ovipositor through the skin of the apple. The eggs being successively developed in the ovary of the female, after the manner of the eggs of the barnyard fowl, the season of egg laying extends over considerable time. The eggs are vertically inserted into the pulp of the apple, with the end opposite the pedicel, which contains the head of the maggot, pointing toward the core. The eggs are deposited in all parts of the apple, usually upon the cheeks, sparingly near the calyx and stem ends, and more abundantly upon the pale or shaded side of the fruit. The time required to deposit the egg is about one-half minute. By means of the sharp ovipositor a characteristic puncture, 33 m m. (.0133 in.) diameter, is made through the skin of the apple. These punctures can be detected

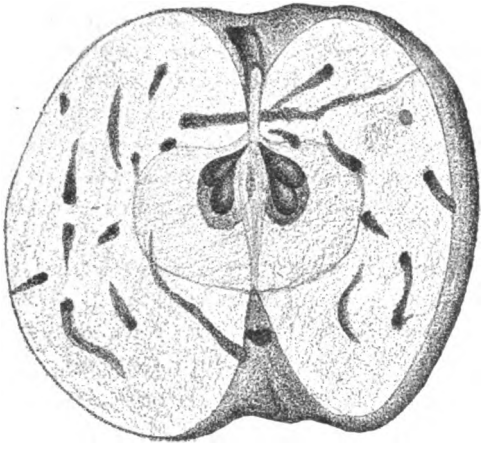


FIG. 3.—Section of apple injured by Apple Maggot or Railroad Worm.

by careful observations with the naked eye, but a pocket lens is necessary to see them well. They appear as brownish specks,

CABOT SCIENCE LIBRARY

Digitized by Google

and have not been before distinguished from the
rusty spots common on apples. Under the glass t
as circular or oblong openings, surrounded by a brown
somewhat shrunken by the shriveling of the tissu
They may be numerous on the same apple. The eg
four or five days under favorable conditions and
larvæ begin at once to work in the pulp of the app
have no true opposable jaws, but the head is provide
black curved hooks, situated above the mouth, with
rasp the pulp of the fruit rapidly by means of a vert
ment of the head. They live upon the juice of p
apple thus detached, which is sucked into the mouth.
is rejected and turns brown. They can burrow thei
soft fruit in less than a minute. The channels m
young larvæ, while the fruit is still growing, are larg
and neither they nor the minute white larvæ are l
detected by the naked eye or by the casual observe
larvæ grow, and the fruit matures, the enlarged c
not heal, but turn brown, and the presence of the
then readily detected. These channels meander th
whole fruit, even the core. They often cross each
large as the larvæ grow, and in the last stages of th
work run together, producing large cavities. Fi
involve the whole fruit, rendering it a worthless m
gusting corruption, held together by the peel."

In regions where this insect is not very abundant,
with thin skins are most likely to be attacked, but
pest becomes more numerous the injury extends
varieties.

The only thorough-going method of checking the
the Railroad Worm and preventing injury to the fruit i
and destroy the windfalls. The worms are in these,
on the ground the maggots leave the apples and burr
earth. By picking up the windfalls every day or e
day and feeding to stock or otherwise destroying
insects will be killed and the development of the next
of flies prevented. Each maggot thus destroyed thi
sens by a hundred or more the maggots of next yea
The flies are sluggish, and generally remain in th

Digitized by Google

ere they develop, so that each fruit-grower, to a large extent, protect himself without the fear of invasion from neighing orchards.

f the windfalls are picked up and fed to stock, only give as ny at one time as will be eaten up clean. Leaving the apples the ground in the pasture long enough for the maggots to out might not help matters much. If no other way of dising of the surplus is found, dig a hole three or four feet p and dump the apples in it, until within a foot of the top. en cover with earth a foot deep. In a well-kept orchard the king up of windfalls, from the middle of July onward, may dily be accomplished; an active boy or two by going over ground daily would find it a comparatively simple matter. preferred, sheep or swine in sufficient numbers to keep the und clear of fallen apples may be turned loose in the ord, either part of the time every day or two, or kept in all while after July 15, if the orchard contains early varieties, later if only late varieties are present.

Spraying does not prevent the injuries of the Apple Maggot; eggs are deposited beneath the skin of the fruit out of the ch of insecticides. The destruction of windfalls, and general an culture is the best way of keeping the Railroad Worm in eck.

Digitized by Google

Digitized by Google

Sci 1636.35

HARVARD COLLEGE
JUN 6 1930
LIBRARY

ulletin 36 June, 1896

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

ANALYSES OF THREE COMMON INSECTICIDES

BY FRED W. MORSE

Insecticides have become a necessity in farm economics, and e quantity used is steadily increasing. Worthless substances ave from time to time been put on the market under various ames, and complaints have been heard that the standard poi- ons have sometimes failed to kill the pests for whose destruc- on they were applied. In the summer of 1895, Professor Veed, entomologist of the Station, collected samples of five fferent brands of Paris green, one of London purple, and one white hellebore, and handed them to the chemist for analysis.

Paris green, when carefully prepared, is a definite chemical ompound, described in text-books under the names of copper ceto-arsenite and Schweinfurth's green, and contains fifty-eight nd six-tenths per cent. of arsenic trioxide (white arsenic), to hich its poisonous properties are mainly due. The ordinary rticle, however, varies in composition between rather wide mits. In Louisiana, a statute requires the substance to con- in not less than fifty per cent. of arsenic trioxide.

In the bulletins of several of the agricultural experiment sta- ons,* there have been reported fifty-four analyses of Paris

* Alabama, Bull. 58; Cornell, Bull. 18; Florida, Bull. 14; Louisiana, Bulls. 1 and 12; series; Massachusetts, State Sta., Rep. 1894; Hatch Sta, Bull. 38; South Caro- a, Rep. 1888; Texas, Rep. 1888; Vermont, Bull. 12.

CABOT SCIENCE LIBRARY

Digitized by Google

green, forty-three of which showed more than fifty per cen the trioxide, and eleven less.

The proportions found in the samples analyzed at this tion are given in the following table:

ANALYSES OF PARIS GREEN

Manufacturers.	Per cent arsenic trio
C. T. Reynolds & Co., New York,	56.3
Boston Color Co.,	55.9
Sondheim, Alsberg & Co., New York,	55.6
James A. Blanchard, New York, "Lion Brand,"	56.6
Nash, Winslow & Co., Boston,	55.3

These results show no adulteration, being nearly up to theoretical composition.

ANALYSIS OF LONDON PURPLE

London purple is prepared from a waste product obtaine making aniline dyes, and consists mainly of calcium arse and a dye-stuff. The mixture cannot well be constant in composition; but so far as learned, the proportion of ars trioxide varies no more widely than in Paris green.

Four analyses of the article have been reported from as m different agricultural experiment stations,* and the aver amount of the trioxide was forty-three per cent., or about th fourths of the quantity contained in the more common inse cide.

The result of the examination of the single sample at station is given below.

Manufacturer.	Per cent arsenic trio
Hemingway's London Purple Co., London, England., Leggett & Brother, New York, licensed packers,	37.5

WHITE HELLEBORE

White hellebore, the third insecticide examined, is a stance of a different nature from the others previously descril It contains no arsenic, being a purely vegetable poison. may be prepared from two species of false hellebore (*V*

* Cornell, Bull. 18; Florida, Bull. 14; South Carolina, Rep. 1888; Vermont, Bu

Digitized by Google

rum) ; the white hellebore (*Veratrum album*), which grows in Europe, and the green hellebore (*Veratrum viride*), or Indian poke of our wet meadows.

Gray's "Manual" considers the two species as very nearly identical ; but the "Treasury of Botany" states that the white is more powerful than the green. The insecticide consists of the pulverized root-stalks of the plants, and contains the poisonous alkaloid, veratria. The most probable way of adulterating hellebore would be by adding earthy matter, to increase the weight. Such adulteration is easily detected by determining the quantity of ash.

The sample of hellebore examined, bore the label: "Best quality pure powdered hellebore. Put up by West & Jenny, Boston."

The analysis showed 33.13 per cent. of ash, which contained an abundance of iron and aluminum oxides, and insoluble siliceous matter, indicating considerable adulteration with clay.

Two analyses of hellebore were found in the report of the Massachusetts State Station, for 1889. One of the analyses showed less than seven per cent. of ash, and the other over forty. The former was evidently a pure sample, while the latter was reported to contain the same clay constituents found in the sample at this station.

Recently, four additional samples of hellebore were procured and their ash contents determined. One sample purchased of a dealer in farming tools, was in a sealed package, labeled "Leggett's Hellebore," and was prepared by Leggett & Brother, of New York. It contained 16 per cent. of ash.

The three other samples were bought of druggists from stock kept in bulk. One of the samples yielded 12 per cent. of ash, another 10.6 per cent., and the remaining one 34 per cent.

Three of these four samples may be considered as pure, although containing a high percentage of ash for vegetable matter. Unless the roots were thoroughly washed before pulverizing, there would undoubtedly be considerable earthy matter in the powdered article. But the last sample must either be adulterated, or very inferior in quality.

In conclusion, it must be said that no adulteration was found

CABOT SCIENCE LIBRARY

Digitized by Google

at this station, in the insecticide most abundantly used. Should any reader of this bulletin, living in this state, have any Paris green on hand, which has failed to act in a poisonous manner, this experiment station will gladly examine a sample, if sent with postal or express charges prepaid.

Digitized by Google

Sci 1636.35

Bulletin 37 July, 1896

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

CRIMSON CLOVER

BY F. WM. RANE

This plant is by no means new, although it is little known in New Hampshire. It has been tested by many persons on a small scale with very variable results. The main difficulty appears to be its inability to withstand our severe winters. Perhaps two thirds of those who have tried it report a complete or partial failure, while the remainder seem to be very enthusiastic over their success.

A strip sixteen rods long by one rod wide was sown on the college farm last August together with some rye for protection. It germinated nicely and before winter set in was 5½ inches high. The winter was a comparatively open one; other clover and grass lands heaved and froze out badly. Regardless of these conditions about 22 per cent. of the plot came through all right. We were unable to get a photograph of it until it was just going out of bloom, as is shown in Fig. 1. Where it did come through the winter, it looked well, stood on an average 18½ inches in height, and made a fine crop.

Crimson clover is also known as scarlet clover and Italian or German clover. It is an annual, requiring seed for each crop. The flower heads are bright crimson in color and

CABOT SCIENCE LIBRARY
CABOT SCIENCE LIBRARY

Digitized by Google

from 1½ to 2 inches long. The plants attain a height of
12 to 26 inches.

TIME TO SOW

This question we are unable to answer definitely as reg
New Hampshire. It is requested that all who have alr
grown it should inform us as to their results, that some s
factory conclusions may be reached. The general impres
is that it has not proved hardy enough to fully withstan
winters in this state. In Delaware, where 2,340 acres
sown in 1891, it is planted the latter part of July or du
August. This crop may be cut for silage or hay earl
May and a yield of from one to two tons per acre ma
secured from very poor land. The plants from the
sown here last August blossomed during the latter par
May. It is claimed that if it is sown in July it will ma
growth by fall, which may be used for pasture during Oct
and November, as a good substitute for hay. The rem
may be plowed under in the fall, or should it withstand
winter, may be used for soiling or green manuring the
spring.

We have sown to-day, June 29, about two acres with
idea of plowing under all but a strip, as a green manure
fall. The land is a light soil which has been exhauste
growing grass. It was plowed last December and has
thoroughly harrowed; and now if crimson clover will fu
the soil with organic matter, it will be a cheap way of fer
ing.

Another use to which crimson clover may be put is
fertilizer in fruit plantations. It should then be sowed
latter part of July or first of August, when cultivation ce
and later turned under. It ought to make a valuable crop
this purpose.

As a further experiment we expect to sow seed every m
from now on in order to ascertain whether it will winter b
at certain stages of growth than others.

SEED PER ACRE

The seed weighs sixty pounds to the bushel and from
to sixteen pounds are necessary to seed an acre properly

Digitized by Google

claimed that there are five types of crimson or scarlet clover, l that but one of these is hardy; therefore it pays to pur- ase from reliable seedsmen.

GREEN MANURE

Experiments have shown crimson clover to be a very valu- e green manure, like all the other plants of the clover group. ose of the Delaware Experiment station go to show that m a standpoint of nitrogen alone it is more valuable for owing corn than nitrate of soda. It also has been used as substitute for nitrate of soda with other crops with good ults. In one ton of green material there are approximately pounds of potash, 2⅔ pounds of phosphoric acid, and 8⅔ unds of nitrogen.

COST OF SEED

It is subject to market changes. If purchased by the bushel xty pounds), the price this year averages about four dollars sides the freight rates. This practically makes the expense seed come at one dollar an acre. For smaller quantities the ces range somewhat higher, averaging from ten to fifteen nts per pound.

CULTURE

The culture is simple as in most cases where it is used it is wn in connection with some other crops eventually to have e whole space when the latter is harvested. With corn, for ample, it is sown after cultivation has ceased. It is used nilarly in gardens and orchards, being only sown on the rface after cultivation. On stubble land the best results are tained by harrowing deeply, then sowing the seed and firm- g or harrowing it lightly. Mr. E. W. Allen says, "Failure secure a stand of crimson clover is frequently due sometimes the seed and sometimes to the season." The one we can gulate while the other we can not.

EXPERIMENTS IN WESTERN NEW YORK

In a recent Bulletin (No. 117) from the Cornell University xperiment Station Prof. Bailey concludes that portion of the lletin under the head "Crimson Clover in Orchards" with e following paragraph:

Digitized by Google

"As the result of our experiments last season with clovers, we will not sow any more crimson clover on any scale until we have experimented further with it, but wil medium red, sown in our orchards about June 15 to July 20 But we are not yet ready to give any final opinion upon question.

"Persons err in looking for a too heavy stand of cri clover. It must not be expected to give the amount of her which the ordinary clover seeding does. Even a thin cove if it passes the winter, is very useful in improving the c tions of the land; and a good fall stand which wholly kill during the winter is also worth the growing upon the gr part of our fruit lands. We are convinced that crimson c has come to stay, but we are equally convinced that it is un to rely upon it year by year for a cover crop. It will fi place in a judicious alternation of cover crops, the parti alternation to be determined by every farmer for himself."

GENERAL REMARKS

This crop is one worthy of our consideration and shou tried very generally, on a small scale at least. If it is of to New Hampshire the public should know it. We in making a thorough test of it at the Experiment Station, b soils differ it is well to compare notes and in this way much more satisfactory knowledge of it. In cutting using crimson clover for hay it should be done before it i of blossom, as otherwise the dry, prickly heads are liab lodge in the stomach, producing balls of felty material th some instances have caused death to animals.

Digitized by Google

Sci 1636.35

THE TENT CATER= PILLAR

BY

CLARENCE M. WEED

The caterpillars lay their eggs on the branches of apple trees, and being hatched by the warmth of the spring, they form clusters, and inclose themselves in a web, whence they issue forth in quest of food, and destroy the leaves of this and other trees.—Jeremy Belknap, History of New Hampshire, 1792.

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

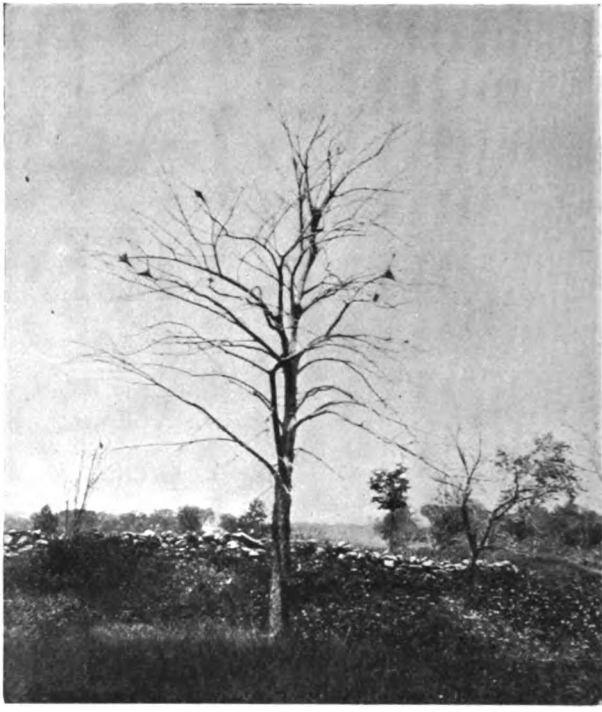
Bulletin 38 August, 1896

CABOT SCIENCE LIBRARY

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

These pernicious pests spread in every direction from the
of the careless and the indolent to those of their more carefu
industrious neighbors, whose labors are thereby greatly incr
and have to be followed up year after year without any pr
of permanent relief.—T. W. HARRIS, 1841.



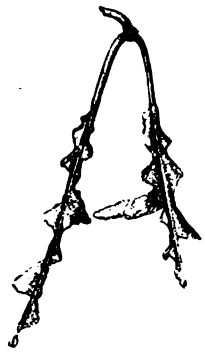
A WILD CHERRY TREE IN "THE LEAFY MONTH OF JUNE"

There is certainly no justice or reason for permitting a f
many men in a community to shield and shelter insects tha
soon swarm over the grounds of neighbors, but as nothing les
the severe lash of the law will reach the stolidly indifferent i
matters, we are forced to submit and fight these enemies a
invade our gardens and orchards.—ANDREW S. FULLER, 1

Digitized by Google

THE TENT CATERPILLAR

BY CLARENCE M. WEED



MONG the many insect pests of the Granite State none is more in evidence during spring and early summer than the Tent Caterpillar,* which for more than a century has ravaged the orchards of New England. In 1790 Samuel Dean wrote from Portland, Mass.: "The principal inconvenience the farmer meets with from caterpillars is the damage they do to his orchard. A hairy kind of caterpillars build their nests on apple trees in May, and are gone entirely in June. But they eed so industriously on the leaves as to destroy a great part of hem if they be not timely prevented. As they are far less nischievous than the canker-worm, so they are more easily ubdued."†

Fifty years later Dr. T. W. Harris, of Cambridge, Mass., vrote of "the caterpillars that swarm in the unpruned nurser-es and neglected orchards of the slovenly and improvident husbandman, and hang their many coated webs upon the wild herry trees that are suffered to spring up unchecked by the vayside, and encroach upon the borders of pastures and fields." During recent years these insects have also been very abun-ant, and have often defoliated orchards, either alone or with he assistance of the canker worm.

Apparently, many people do not realize the seriousness of

Clisiocampa americana.

† New England Farmer or Georgical Dictionary, 1790, p. 41.

CABOT SCIENCE LIBRARY

Digitized by Google

the injury when a fruit tree is stripped of its leaves. I
effort to repair the damage the tree will put out new foli
thereby using up the stored materials that otherwise woul
utilized for growth or fruit. Even in case no blossoms ap
the season the damage is done, so that no loss of fruit that
may be felt, the effects will be evident in next year's crop.
preservation of the leaves in wholeness and health is neces
to the preservation of the tree in a profitable condition;
orchardist cannot afford to have the leaves removed or injur

FIG. 3.—Apple Leaves eaten by Tent Caterpillars (Original)

The injury done by the tent caterpillar is at once distinguis
from that of the canker worm by the fact that the former
the body of the leaf, veins and all, leaving only the midri
larger veins (Fig. 3), while the canker worm feeds upon
surface of the leaf, leaving the brown network of veins.
severe attack of the tent caterpillar renders the tree almos
bare in June as it is in mid-winter—a condition shown in
illustration on the second page of this bulletin—while a sim
attack by the canker worm gives the tree a brown appearar
somewhat as if it had been scorched by fire.

Digitized by Google

THE HISTORY OF A CATERPILLAR'S LIFE

FIG. 4. Egg-Mass (Original)

FEW insects pass so long a portion of the year within the eggs as do the Tent Caterpillars. In July the eggs are laid in masses of 200 or more in a cylindrical cluster upon the twigs of apple and wild cherry. After they are deposited the parent moth covers them with a viscid liquid, which dries into a sort of varnish that completely coats them, as represented in Fig. 4. The insect remains in this egg state from July until the following spring, when the little caterpillars emerge from the eggs and begin feeding upon the tender foliage of the buds about them. In a few days they begin to make a silken tent, utilizing generally, for this purpose, a fork of the branch. As time goes on the nest is enlarged. The caterpillars retire to the tent at night, and during cold and wet weather, and when not feeding. They have regular times for their meals, leaving and returning to the nest in processions. They become full grown in about six weeks, being extremely voracious during the latter part of their development. They are then nearly two inches long, with a hairy body, ornamented with a distinct white stripe along the middle of the back, on each side of which are numerous short, yellow, longitudinal lines, rather irregularly arranged. The sides are partially covered with paler lines, spotted and streaked with blue, while the lower surface of the body is black. The full-grown caterpillar is represented in Fig. 5.

When the caterpillars become full grown most of them leave the tree where they have developed, and crawl about in search of shelter. Early in June thousands of these caterpillars may be seen rapidly crawling along the ground, especially by the

CABOT SCIENCE LIBRARY

Digitized by Google

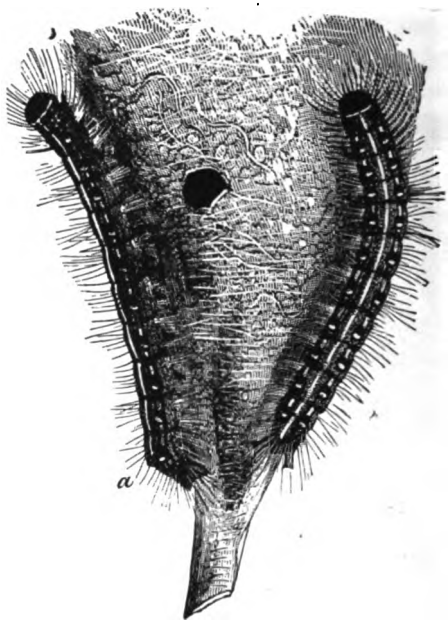


FIG. 5.—Tent Caterpillar (After Riley)

roadside. When they find a satisfactory situation, beneath a board, in the cracks of a fence, or between pieces of rough bark, they spin an oval, silken cocoon (Fig. 6), yellow when completed, within which they change to the quiet pupa or chrysalis state.

FIG. 6.—Cocoon of Tent Caterpillar (Original)

Digitized by Google

Two or three weeks later another change takes place, and
m each cocoon there comes forth a reddish-brown moth
ig. 7). The male moths are considerably smaller than the
females. These moths are nocturnal, flying only at night, and are to be found throughout the greater part of July. The females deposit the eggs upon the twigs of trees and soon die. As already stated, these gs remain unhatched until the following spring.

. 7.—Female Moth (After Riley)

THE EXTENDING RANGE OF FOOD PLANTS

The ordinary food-plants of the tent caterpillar are the apple
d the various kinds of wild cherry. The moths apparently
oose these in preference to all other trees for the reception of
e egg-masses. But during the outbreaks of the insect in New
ngland the last few years, as in fact in previous outbreaks in
ner regions, many of the caterpillars have been forced by
nger to attack the foliage of other trees and shrubs. In many
calities the leaves of the apple and cherry trees upon which
e insects fed when first hatched, have been wholly devoured
fore the caterpillars were half grown. Of course this must be
e result when more egg-masses are laid upon a tree or shrub
an can be matured upon its leaves. Thus threatened by star-
tion the caterpillars have been forced to leave their nests,
scend to the ground, and crawl about in search of food. Many
them ascend the nearest trees and shrubs, and nibble at their
aves. If these leaves are not too distasteful the caterpillars
e likely to remain and complete their growth upon the new
od-plant thus found. If the insects are unable to live upon
e leaves they are likely again to crawl away in quest of some-
ing better. Doubtless thousands of them perish outright in
is search for food, while myriads of others prematurely change
pupæ, and either die before maturing into moths, or develop
to feeble adults.

But it is very probable that many of these caterpillars which
e able to complete their larval growth upon new food plants

Digitized by Google

will survive all vicissitudes and mature into moths that apparently are likely to deposit eggs upon the variety of tree that has furnished them food. In this way the insect will be likely soon greatly to extend the limits of its food-supply, and become much more difficult to subdue than it now is. The case is suggestive of the famous Gypsy Moth that has lately been causing such alarm in Massachusetts. The unusual noxiousness of this

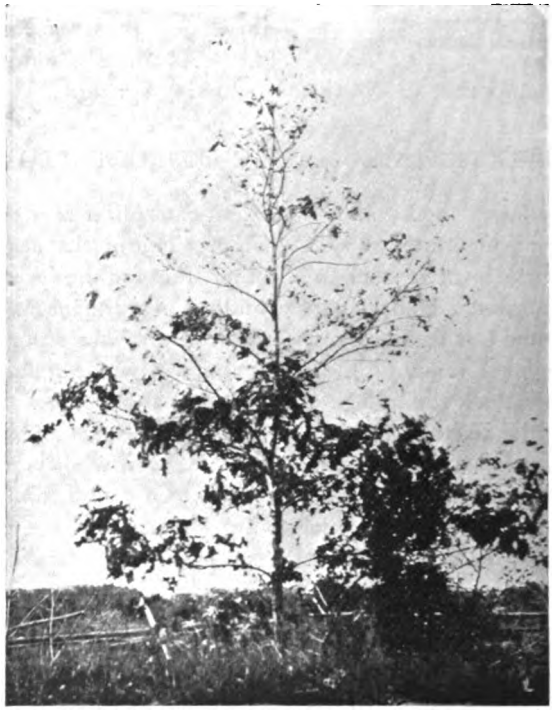


FIG. 8.—Oak Tree partially defoliated by Tent Caterpillars (Original)

pest arises from the ability of the caterpillars to feed upon leaves of all sorts—hard wood trees, evergreens, shrubs, and herbaceous plants. Therein lies its menace; and if the tent caterpillar is permitted to continue establishing itself upon new food plants, our descendants may have a somewhat similar pest to contend with.

Digitized by Google

That this is not an imaginary danger can be seen from Fig. 3, and from other photographs which we took but have not reproduced in this bulletin, showing the work of the tent caterpillar upon trees and shrubs not on its usual bill of fare. And the most suggestive fact in connection with these changes of food is to be found in the great dissimilarity of the other food plants. The apple and cherry belong to the great rose family of plants; botanically speaking they are related to each other as well as to the rose, the peach, the pear, the plum, the mountain ash, and others. It is well known that insects have family preferences in the matter of food; that if a given insect feeds upon a given plant we need not be surprised to find it also upon another plant closely related, belonging to the same family.

FIG. 9—Diseased Tent Caterpillars (Original)

In view of this we should expect the tent caterpillar when it was forced to increase its range of food to attack the peach, cultivated cherry, rose, and other plants of this family. This has been done, and each of these is now on the tent caterpillar's food list, but we have also found it feeding freely and apparently thriving upon such widely separated plants—so far as botanical kinship is concerned—as the oaks (Fig. 8), the hickories, the birches, (see photograph on title page,) the barberry, and the willows and poplars. I found a large tent even upon the low evergreen known as the juniper, but the caterpillars from it evidently fed upon a neighboring barberry.

CAROT COLLEGE LIBRARY

Digitized by Google

During the latter part of the caterpillar seaso
frequently find dead and dying caterpillars upon the
the tent, stretched at full length. Some of these wil
sluggish, others evidently nearly dead, others dead
ing at a touch, letting escape the liquid decomposed
tents. Some will be hanging by one end of the
tent or twig, as shown in Fig. 9. These caterpillar
be affected by one of the bacterial diseases that are
develop in many insect larvæ when they become
dant. The army worm and common cabbage wor
quently destroyed in great numbers by such diseas
there appeared to be more of these diseased larva
than last in southern New Hampshire, the disease w
ciently destructive to give great hope for the imm
pression of the outbreak. The fact of each co
somewhat isolated from others will tend to prevent
from affecting all the caterpillars of a region.

After the tent caterpillars are half grown there ma
in many of the nests small dead specimens with the
len and the skin dry and h
10). If these are placed in
themselves, a fortnight or so
four-winged flies will emerge
These are parasitic ichneu
They have developed from e
in the young caterpillars by similar parent flies.
hatched into grubs or larvæ that developed on the i
caterpillars, killing them and absorbing all the bo
the skin. Within the latter the larvæ pupated, to e
as flies. We reared many of these parasites, w
kindly determined by Mr. L. O. Howard as *Pimpla*

FIG. 10—Parasitized Caterpillar (Original)

Comparatively few birds feed upon hairy larvæ li
caterpillar, but some, like the cuckoos and blue ja
them eagerly. The European cuckoo is said to reg
mass of hairy skins swallowed with the caterpillars,
ably our species have the same habit. Many obse
noticed that both the Black-billed and the Yellow-bille

Digitized by Google

ed upon the tent caterpillars. For example, Mr. C. E. Bailey ates:* "On May 10 a Black-billed Cuckoo came into a tree ar me at 3 P. M., and sat there until 4:40 P. M., then he went raight to a tent caterpillar's nest. He looked it over for a ort time, and then commenced eating the caterpillars. He cked twenty-seven caterpillars out of the nest before he opped. The bird ate them all and did not drop one."

Mr. E. H. Forbush gives* the following list of birds found

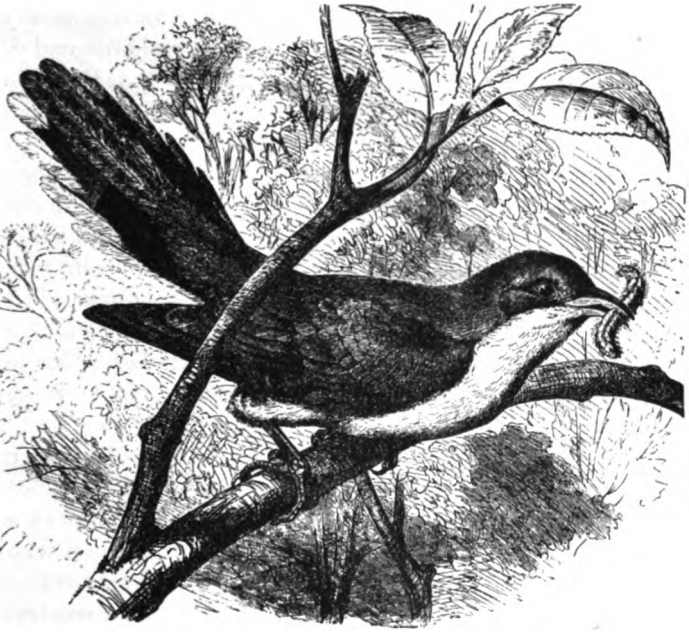


FIG. 11.—Yellow-billed Cuckoo (After Brehm)

eding on tent caterpillars in a Massachusetts orchard in 1895: row, Chickadee, Baltimore Oriole, Red-eyed Vireo, Yellow-lled Cuckoo, Black-billed Cuckoo, Chipping Sparrow, Yel-w Warbler. Other birds have also occasionally been reported feed upon these pests, but birds do not do so much toward eir destruction as they do toward the destruction of the can-er-worm, the latter being a much more edible insect.

My observations upon the natural checks upon the tent cater-

* Mass. Crop Report, July, 1895, p. 29

Digitized by Google

pillar lead me to believe that it is not good polic
upon them for subduing the pests. It will be muc
the intelligent people of each community to attem
public opinion so that each man will destroy the
upon his own premises and along the adjoining roa

METHODS OF DESTROYING TENT CA LARS

The tent caterpillar is open to attack in a varie
and should by no means be allowed to injure orcha
figure the roadsides as it has been doing recently.
with the eggs the principal remedial measures may
rized as follows:

1. *Destroying the Eggs.*—During winter and e
the egg masses may readily be seen upon the smalle
and are easily removed and burned. In this work b
employed to advantage; their sharp eyes and nimbl
likely to accomplish as much as their elders. A
since a society in a Massachusetts town offered p
youngsters of the community for the collection
caterpillar egg-masses, and thousands were thus
The same result may to a large extent be accomplis
ting off and burning the thickets of wild cherry t
roadsides, and stand in clusters in pastures and fi
should be done after the eggs are laid, and befo
hatched—any time between September 1st and Apr
do. If in a given community the eggs on these w
were thus destroyed the next season's crop of worm
greatly lessened, and attention could be concentra
tents in the orchards. Such a burning of the wild c
also destroy millions of spores of black knot—the f
ease that is always threatening cultivated plums a
because of its almost universal presence on the wi
The pest-breeding, neglected apple trees bearing n
so often seen along the roadside, should also be co
firewood, and the branches burned during fall or wi

2. *Killing the Young Caterpillars.*—When the
are young and the nests are small, it is easy to

Digitized by Google

colony by swabbing it out of the crotch with a mass of rags, a gloved hand, a forked stick, a scrubbing brush, or almost anything that can be used to crush the tiny worms huddled beneath the tent. Of course this destruction should take place when the caterpillars are at home rather than when they are abroad on the branches feeding. In rainy weather one can generally find them in the tent almost any time, while in fair weather they may be attacked either early or late in the day. The colony can also be removed by taking hold of the outside of the tent with the hand and lifting it with the worms inside: then drop it to the ground and step on it. When the tent is on a small branch the latter may be cut off and then burned or crushed. "A slender pole long enough to reach the highest nest in the tree," writes Mr. A. S. Fuller, "with two or three shingle nails driven through the end, leaving the heads sticking out a half inch, makes a very handy and efficient implement for dislodging the nest and caterpillars. By thrusting the end into the tent and then twisting it around two or three times the tent will be rolled about the end and can be drawn forth with contents," and destroyed.

There appears to be a considerable variation in the time of hatching of the different egg-masses, so that it is often necessary to go over the trees more than once to get all the nests. As a rule one should not be satisfied with a single attack upon the pests, but should renew the battle if necessary.

3. *Burning with Torches.*—A rather common method of destroying tent caterpillars is to burn them out by means of some substance saturated with kerosene. An asbestos torch advertised by the seedsmen and implement dealers for this purpose is represented in Fig. 12. The asbestos is saturated with kerosene, lighted and held under the tents for the cremation of the caterpillars. Rags tied to the end of a pole and satu-

FIG. 12.—Asbestos Torch

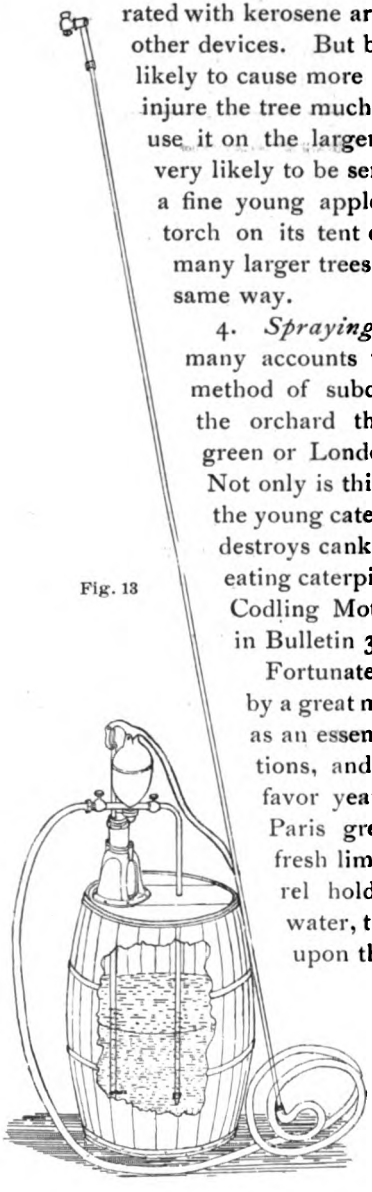
CABOT SCIENCE LIBRARY

Digitized by Google

rated with kerosene are also used, as well as va
other devices. But burning is a remedy whi
likely to cause more harm than good. It ma
injure the tree much, but one is always tempt
use it on the larger branches where the ba
very likely to be seriously damaged. I have
a fine young apple tree killed by the use
torch on its tent caterpillars, and have kn
many larger trees to be seriously injured i
same way.

4. *Spraying with the Arsenites.*—
many accounts there is no more satisfa
method of subduing the tent caterpilla
the orchard than by spraying with
green or London purple mixed with w
Not only is this pretty certain to kill o
the young caterpillars on the trees, but i
destroys canker worms and also other
eating caterpillars as well as the larvæ
Codling Moth or Apple Worm, disc
in Bulletin 35 of this Station.

Fig. 13



Fortunately spraying has been ad
by a great many commercial fruit-gro
as an essential part of the season's o
tions, and the practice is growin
favor yearly. Four or five ounc
Paris green, with a pint or tw
fresh lime water, are added to a
rel holding forty or fifty gallo
water, thoroughly mixed and sp
upon the trees soon after the w
hatch, by means of a
pump and spray nozzle
simple and effective s
ing outfit, which has
used to good advanta
the experiments at thi
tion, is represented in

Digitized by Google

. It consists of a kerosene barrel holding fifty gallons, a rce pump having a double discharge, with a short line of ose running into the barrel to keep the liquid stirred, and long line of hose fitted at the end to a slender brass rod pped with a spray nozzle. This outfit can be obtained rough any hardware dealer, or direct from any of the nu- erous manufacturers of spraying machinery.

FIG. 14.—Tent Caterpillar on Oak (Original)

Digitized by Google

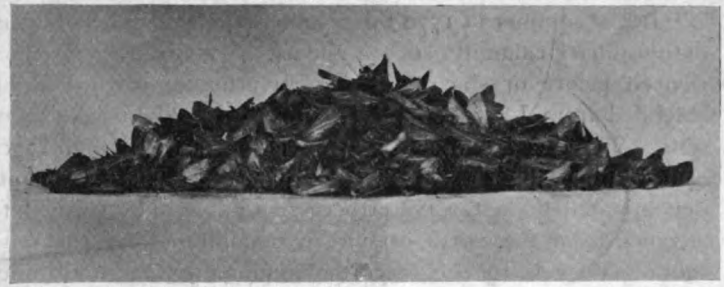
Digitized by Google

Sci 1636.35

Bulletin 39 September, 1896

NEW HAMPSHIRE COLLEGE

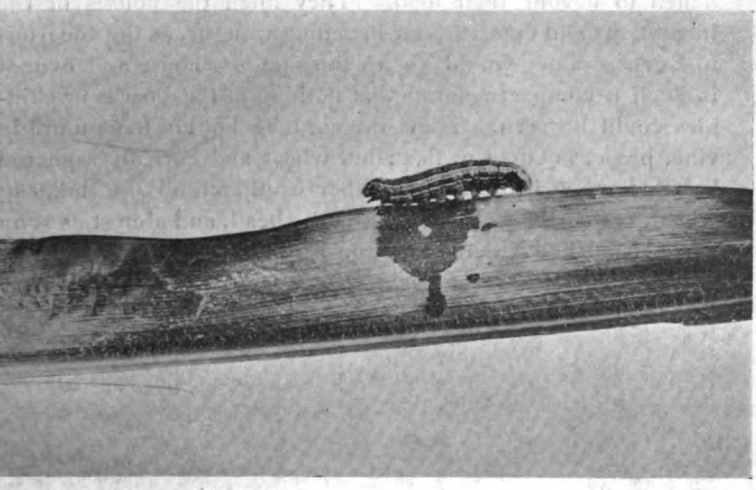
AGRICULTURAL EXPERIMENT STATION



A Thousand Army Worm Moths

THE ARMY WORM

BY CLARENCE M. WEED



CABOT SCIENCE LIBRARY

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

THE ARMY WORM IN NEW HAMPSHIRE IN 1770

"In the summer of 1770 this whole section was visited b
extraordinary calamity, such a one as the country never e
rienced before or since. It was an army of worms w
extended from Lancaster, N. H., to Northfield in Massa
setts. They began to appear the latter part of July, 1
and continued their ravages until September. The inhabit
denominated them the "Northern Army," as they seeme
advance from the north or northwest and to pass east
south. They were altogether too innumerable for multit
Dr. Bouton of Thetford, Vt., told me that he had seen w
pastures so covered that he could not put down his finger
single spot without placing it upon a worm. He said he
seen more than ten bushels in a heap. They were unlike
thing which the present generation have ever seen! T
was a stripe upon the back like black velvet, on either si
stripe from end to end, and the rest of the body was bro
. . . They appeared to be in great haste, except when
halted to devour their food. They filled the houses of
inhabitants and entered their kneading troughs, as did the f
in Egypt. They would go up the side of a house and ov
in such a compact column that nothing of the boards or s
gles could be seen. They did not take hold of the pump
vine, pease, potatoes or flax; but wheat and corn disappe
before them as if by magic. They would climb up stalk
wheat, eat off the stalk just below the head, and almost as
as the head had fallen upon the ground it was devoured
*The Reverend Grant Powers, Historical Sketches of the
Country, Haverhill, N. H., 1841.*

Digitized by Google

HE ARMY WORM IN NEW HAMPSHIRE

BY CLARENCE M. WEED

Early in July, the present season, complaints began to reach e Experiment Station of the injuries inflicted by the Army orm* upon grain and grass fields. Whenever specimens ere submitted, they proved to be the true Army Worm. In dition to the accounts received by us direct from correspond-ts, there were many notices in the daily papers, showing the esence of the pest in various parts of the state. The data at nd indicates that there were local outbreaks, here and there, er a large part of New Hampshire, especially in the south-n half and the region bordering the Connecticut river.

Serious injury, especially in barley fields, was done during ly; and again in September, when another brood of worms d developed, especial damage was reported to be done in lds of Hungarian grass.

As soon as the first outbreak was reported, I visited the ested fields, studying the worms at work, and bringing speci-ens to the station, where they were placed in breeding cages determine their life-histories. The results of these and sub-quent studies, as well as a summary of our knowledge of the sect in general, are embodied in this bulletin.

PREVIOUS OUTBREAKS OF THE ARMY WORM

The army worm is believed to have occurred in New Eng-nd as long ago as 1743, a year when, according to early cords, there appeared "millions of devouring worms in mies, threatening to cut off every green thing." That the st was present in New Hampshire in 1770, is shown by the otation on the second page of this bulletin. There is little idence of its again occurring in New England in great abun-nce until 1861, when it was very destructive, as it was also

* *Leucania unipuncta.*

Digitized by Google

in 1875. The last serious and widespread outbreak in N England appears to have been that of 1880. The present s son the injury by army worms has been very general, not o throughout New England, but in many other eastern states.

The Army Worm is generally destructive in seasons follow years of unusual drouth. It is seldom injurious in a gi

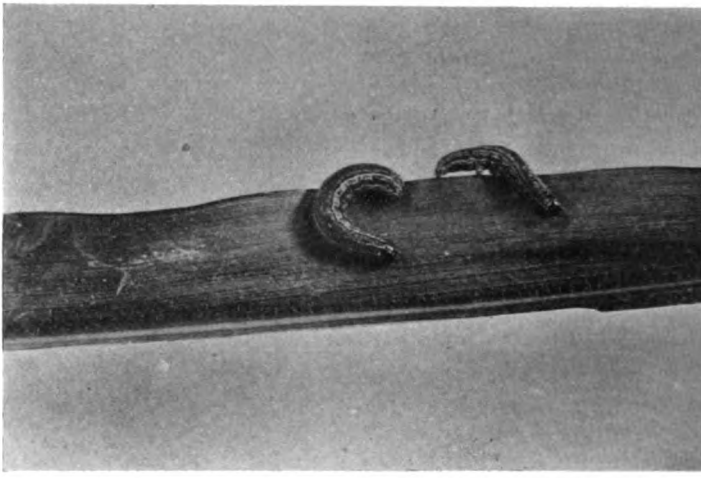


FIG. 3. Two Army Worms. From photograph by New York Experi Station.

locality for two successive summers, but it is worth whil burn over—in autumn, winter, or spring—fields where it be present.

THE LIFE OF THE ARMY WORM

The story of the life of the individual army worm ma briefly told. On some summer night there appears in meadow a good-sized light brown moth. Flying about finds a cluster of strong-growing grass. Into the folded le of one or more of these she pushes a number of small wh eggs, gluing them in rows of a dozen or more. A week or days later each egg hatches into a minute, whitish worm, nibbles at the grass blades at night, and in the daytime h beneath the grass from the rays of the sweltering sun.

Digitized by Google

It grows rapidly in size. At the end of a week it moults or casts its skin, a process in which the old skin splits open along the back and the worm crawls out, clothed in a new skin that had developed beneath the old one. Again it feeds as before, its voracity increasing with its size. This moulting is repeated four or five times during the month after the worms hatch, so that by the end of this period the insect is an inch and a half long, and has the familiar markings of the full-grown army worm.

The instinct of the worm now teaches it to seek more secure shelter for the helpless stage upon which it is about to enter. It burrows into the soil an inch or less and wriggles about in the earth until it produces a hollow cell. In this it casts its skin again and becomes a pupa—the third stage of its existence. When the worms are very abundant, many of them do not go into the ground but change to pupæ beneath whatever shelter may be at hand. About a fortnight later, another change takes place, and the fully-developed moth emerges from the pupa, thus completing the round of the insect's life. The moths fly towards dusk and at night, and by means of their long tongues, coiled up when not in use, they suck the nectar of various flowers.

The moths sometimes seem attracted by buildings. I have been told of their swarming toward the close of cloudy afternoons about barns and outbuildings; and early in August, this year, they were trapped by thousands in the projecting porch of Thompson Hall. We killed one thousand of these moths, placed them in a little heap, and photographed them. The photograph is reproduced on the title page of this bulletin. It represents the moths about one-half natural size, and seems a small pile, but had the moths not been killed there might have developed from them in September nearly half a million army worms.

THE ARMY HABIT

During ordinary years the army worm is present in most of the regions where its outbreaks occur, individual worms feeding here and there in meadows and pasture lands, but the number is not sufficient to attract notice. At such times their

Digitized by Google

habits of life are very similar to those of the common cutw
to which, indeed, the army worms are closely related.
only when these insects become so excessively numerous
they exhaust the food supply of the field in which they dev
that the "army" habit is assumed. Then, however, the
forced to seek new quarters for food, and as their only mo
progress is by crawling along the ground, they move in

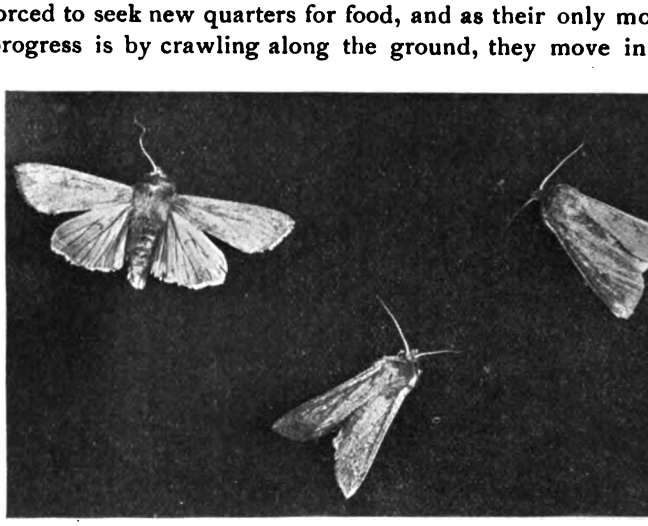


FIG. 4. Moths of Army Worm: natural size. (Original).

masses toward adjacent fields. "Their numbers at
times," wrote Dr. C. V. Riley, "are often so enormous
their voracity so great, that it is impossible for one wh
not been an eye witness to appreciate it fully. * * *
army worm when traveling will scarcely turn aside for any
but water, and even shallow water courses will not a
check its progress, for the advance columns will often
tinue to rush headlong into the water until they have
ciently choked it up with their dead and dying bodies t
ble the rear guard to cross safely over. I have noticed
after crossing a bare field or bare road where they are
jected to the sun's rays, they would congregate in imm
numbers under the first shade they reached. In one insta
recollect their collecting and covering the ground five
deep all along the shady side of a fence for about a

Digitized by Google

FIG. 5. Head of timothy grass gnawed by army worms. (Original).

while scarcely one was seen to cross on the sunny side of the same fence." This avoidance of the sunshine must have been noticed by every observer of army worm outbreaks. On damp, cloudy days one may find numbers of them feeding near the top of grass and grain stalks, but on hot, sunny days few if any are to be found in such situations. They then occur in the shaded rubbish at the soil surface.

THE CHOICE OF FOOD

The army worm feeds by preference upon plants of the great grass family, which includes both the grasses and grains. The moths are especially attracted, for the deposit of their eggs, to rank growths of grass-like plants. To this is due the fact that in New Hampshire this year the brood of worms destructive in July was oftenest found in barley fields, while that destructive in September ravaged the fields of Hungarian grass. In feeding upon timothy and similar grasses the leaves are first stripped, and in cases of severe attacks the heads will be wholly or partially gnawed off; one such is represented in Fig. 5. They also feed freely upon the leaves and more or less upon the succulent stalks of wheat, oats, barley, rye, sorghum, and Indian corn. Generally they feed upon clover only when driven to it by hunger.

THREE BROODS IN NEW HAMPSHIRE

Apparently there were three broods of worms in New Hampshire this season. Before the destructive brood that appeared in July there must have been a brood developed during late spring or early summer. Some members of this generation, and perhaps most, probably passed the winter as par-

Digitized by Google

tially-grown worms, while others may have wintered over in other stages of the insects' existence, for the broods are by no means definitely limited. In a given field at a given time one may find many sizes of worms. The worms injurious in July were doubtless the second generation for the season. The majority of these entered the pupa state during the middle or latter part of the month and emerged as moths early in August. The first week in August, at Durham, the moths were extraordinarily abundant. The progeny of this brood of moths became full grown larvæ in September, changing to pupæ late in the month, and at this writing (October 19) a few of those in our breeding cages have come forth as moths. But I presume that out-of-doors more members of this brood may have matured by this time, and that larvæ from them will become partially grown before winter sets in. Yet it seems almost certain that many of the pupæ must go through the winter without changing to moths; and that many of the moths must hibernate without laying eggs.

THE LIFE-STAGES OF THE INSECT DESCRIBED

The egg of the army worm moth is a tiny whitish sphere with a diameter of only about one fiftieth of an inch. When first deposited it is dull and opaque, but soon afterward it becomes shiny and more or less iridescent. Just before hatching it appears much darker. The spherical outline in many specimens is changed by the sticky material attached to them at the time the eggs are deposited. Specimens, natural size and magnified, are represented in Fig. 6, *a*, *b*.

The larva when full-grown is of the form represented in Figures 3 and 6 *c*, and the lower illustration on the title page (for which I am indebted to the New York experiment station). It is a smooth, cutworm-like caterpillar, an inch and a half long, generally of a dark gray or dingy black color, "with three narrow yellowish stripes above, and a broader one or slightly darker on each side, thinly clothed with short hairs (to be seen with a lens) which are longer and somewhat thicker on and about the head. The latter is of a polished honey yellow color, with a network of fine dark brown lines and a black line on the

Digitized by Google

ront like the letter V reversed." The size of the mature worms aries considerably, some specimens reaching a length of two nches.

The Pupa into which the full-grown army worm changes efore it can become a moth is represented in Figure 6 *d*. It s a quiet, footless, wingless object, of a bright mahogany rown color, and measures about three-fourths of an inch in ength. At the smaller end there are two pointed projections ide by side, and near the base of each projection is a smaller, nore slender spine with a hooked tip.

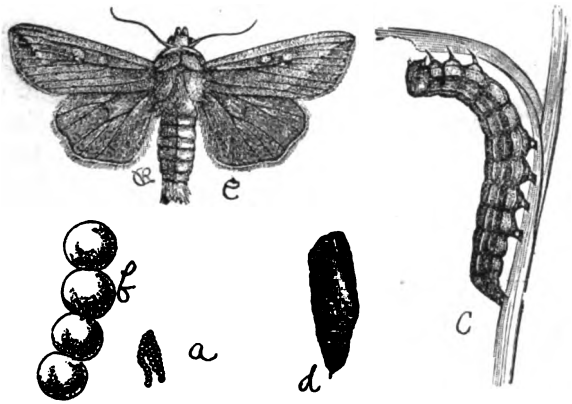


FIG. 6. The Army Worm: *a*, egg-mass, natural size; *b*, eggs, magnified; full-grown larva; *d*, pupa; *e*, moth. (After Riley).

The adult moth into which the army worm develops, and rom the eggs of which it originates, is represented, natural ize, in Figures 4 and 6 *e*. Its expanded wings measure about n inch and a half from tip to tip, although there is considerable ariation in the size of different specimens. The general color f the body and front wings is a peculiar reddish-gray, perhaps nore distinctly described as fawn color. Near the middle of ach front wing are two more or less irregular lighter patches, ach of which on closer study is seen to be made up of three maller spots. Along the side margins of both pairs of wings here is a fringe of feathery scales, immediately inside of which, n each of the front wings, is a row of blackish dots. The ind wings are more grayish, with less of the reddish tinge.

Digitized by Google

THE ARMY WORM'S ENEMIES

Fortunately for the American farmer, the army w
host of natural enemies, which generally keep it belo
ger line. A large number of birds consider the ju
excellent eating, and feed freely upon them. A l
birds would include nearly all our native insectivor
that search for food upon the ground, but specia
should be made of the robin, the blackbird, the bob
the meadow lark, which search grass-lands for in
more persistently than many other of our comm
These and other birds are very useful in keeping ar
and cutworms in check, and should be encouraged by

But the birds are not the only enemies of the ar
In the fields where the pest has been present this s
have also been found a great many large black beetl
them similar to the one represented in Fig. 7, and ot
what larger. During July I examined a barley fiel
the grain had recently been cut
in piles, beneath which the army
congregated in great numbers.
also present beneath each pile abo
of these black beetles, devouring t
worms. These predaceous beetl
monly called ground beetles, becau
habit of living upon the ground,
times they are also called caterpill

FIG. 7. Black Ground Beetle. (After Riley).

There are also many species
parasites that prey upon the arm
Among the most abundant of the
tain two-winged flies that glue eggs upon the ba
worms. The eggs hatch into tiny footless maggots
the bodies of the worms when they hatch, and dev
at the expense of their unwilling hosts. Finally th
worms and the maggots change to pupæ, from whic
emerge as flies. These are called Tachina flies.

There are several species of four-winged Ichne
that have a similar history, and are often very des
the hosts of army worms.

Digitized by Google

The larger ground spiders also feed freely upon these worms; and the moths are often entrapped in the webs of the spinning spiders (Fig. 8).

More fateful and insidious even than these other enemies, are the microscopic germs of a bacterial disease—a sort of insect cholera—that often attacks the army worm when it becomes over-abundant, reducing quickly its invading ranks to below the normal level.

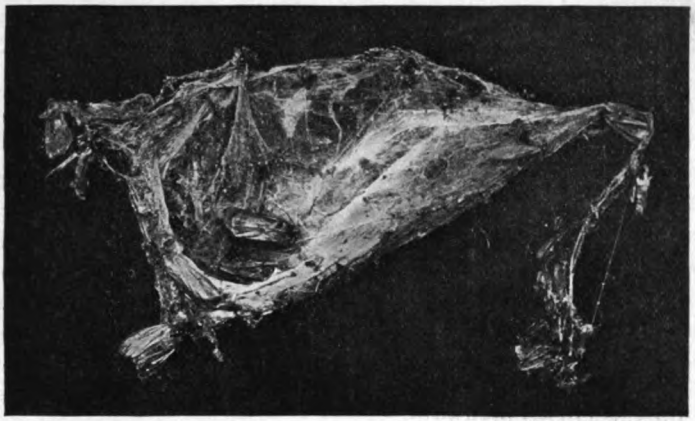


FIG. 8. Army Worm Moths entrapped in a Spider's Web. (Original).

To the action of these various natural checks is doubtless due the seemingly strange appearance and disappearance of this vexatious pest. Nature strives ever to keep a balance in her affairs, and when an insect becomes too abundant, she marshals her various forces to bring it into subjection.

REMEDIAL AND PREVENTIVE MEASURES

When an outbreak of army worms is first noticed, if it is confined to a limited area it is generally well worth while to cut down the grass or grain infested. The worms will remain beneath its shelter for two or three days, and as soon as the cut grass or grain is dry enough it should be burned, thus destroying the pests and preventing the invasion of neighboring fields. The worms may also be destroyed by spraying them with strong

CABOT SCIENCE LIBRARY
Digitized by Google

kerosene emulsion. This is prepared by adding 2
kerosene to 1 gallon of a solution made by dissolvin
of hard soap in 1 gallon of boiling water, and ch
mixture by forcing it back into the same vessel throu
pump with a rather small nozzle, until the whole forn
mass, which will thicken into a jelly-like substance
The soap solution should be hot when the kerosen
but of course must not be near a fire. The emulsion
is to be diluted before using against the army worm
or six parts of water to one part of emulsion. The
dilution varies with different insects. Soft water or
should be used in diluting. If this cannot be obta
little lye or bicarbonate of soda. It should be app
spray pump or nozzle.

Trapping in Ditches and Trenches.—The device
the armies of travelling worms by means of ditches a
occurred to the earliest sufferers from their depred
the New Hampshire outbreak of 1770, Mr. Powers
the inhabitants "dug trenches around their fields a
half deep, hoping this might prove a defense; but
filled the ditch, and the millions that were in the rea
on the backs of their fellows in the trench and took
of the interdicted food. The inhabitants then adop
expedient to save those fields yet standing. They c
as before; then took round and smooth sapling stick
eight inches diameter and six or eight feet in length,
them to a point, and with these made holes in the
the ditch, once in two or three feet; and as thei
were bottom lands, they experienced no difficulty in
these holes to two or three feet in depth below the
the trench. The sides of these holes were made sm
bar or lever which made the holes, and as soon as
stepped from the precipice he ended at the bottom,
not ascend again; indeed, he was soon buried by h
nate fellows who succeeded him in his downfall.
who made these holes to entrap their invaders w
their fields and plunged these pointed levers into
filled with worms, and destroyed every one of them
thrust." Similar methods of fencing off the worms

Digitized by Google

been employed to good advantage since. The side of the furrow or trench next the field to be protected should incline obliquely so that the upper part will be nearer the side toward the worms than the lower part, thus rendering its ascent more difficult. In cases where holes are not dug in the bottom of the trench to trap the worms, they may be killed by dragging boards or small logs along, or by strewing the trench with straw from time to time and then burning it.

Fencing Out.—Some years ago Dr. C. V. Riley wrote: "From experiments which I have made, I am satisfied that where fence lumber can be easily obtained it may be used to advantage as a substitute for the ditch or trench by being secured on edge and then smeared with kerosene or coal tar (the latter being more particularly useful) along the upper edge. By means of laths and a few nails the boards may be so secured

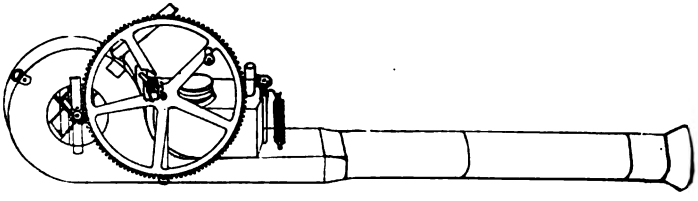


FIG. 9. Standard Paris Green Duster. (Original).

that they will slightly slope away from the field to be protected. Such a barrier will prove effectual where the worms are not too persistent or numerous. When they are excessively abundant they will need to be watched and occasionally dosed with kerosene to prevent their piling up even with the top of the board and thus bridging the barrier. The lumber is not injured for other purposes subsequently."

Poisoning.—One of the simplest ways of preventing injury by the army worm, where it can be done without danger to livestock, is that of dusting or spraying with poison a strip of grass or grain in advance of invaders. The simplest way of doing this would be to apply Paris green when the dew is on in the morning by means of one of the insecticide bellows now upon the market, designed more especially for use against the potato beetle. We have used two patterns of these this season.

CABOT SCIENCE LIBRARY

Digitized by Google

and found them to do excellent service. One of these—the Standard Paris Green Duster—is shown diagrammatically in Fig. 9. It is an admirable machine, and will distribute a pound of Paris green evenly over an acre of potato vines. The other, called Leggett's Insect Powder Gun, is shown in Fig. 10. It is a slightly larger machine, costing also a little more, but it does excellent work. With either of these machines the poison can be applied much more easily than by any other method. The poison can be applied to a strip of grass by the spray-pump or nozzle, or even from a watering-pot, but this is an unsatisfactory way, because the grass-blades do not hold the spray. It would probably be better to dust the poison from the bags on the end of poles. Cattle should not be allowed in the field so treated until there has been plenty of time for the rains to wash the poison into the soil.

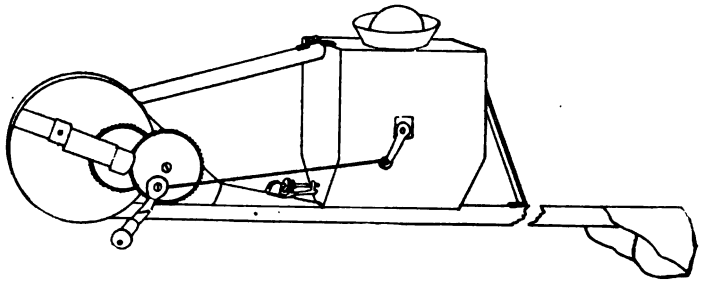


FIG. 10. Leggett's Insect Powder Gun. (Original).

Drawing the Rope.—One of the earliest devices resorted to for the prevention of injury to wheat by the army worm was that of "drawing the rope." In his account of the attack of army worms in 1770, Mr. Powers writes that "two men would take a rope, one at each end, and pulling from each other until it was nearly straightened, they would pass through their wheat-fields and brush off the worms from the stalks and by perpetual action they retarded the destruction of their wheat; but it was doomed finally to destruction." Of course this is a laborious and generally impracticable device, which might be used to advantage only under exceptional circumstances.

Digitized by Google

Burning Over Grasslands.—There is probably no general method that can be used more effectively for destroying army worms than that of burning over, in autumn or early spring, grasslands in which the worms are present. As already indicated, a portion of the pests appear to go through the winter as partly-grown worms. Consequently it seems well worth while to examine carefully fields in which they are likely to be present, and burn them over as thoroughly as is possible. Where it can easily be done, this burning is also advisable as a preventive measure, even in regions where the worm has not been destructive this year. The burning should also include old rubbish heaps and such worthless miscellaneous materials as may serve as a hiding-place for this and other injurious insects, either in the larval or moth states.

CABOT SCIENCE LIBRARY
GIFT OF
Digitized by Google

Digitized by Google

The Farm Houses
University of Nebraska
Sel 1636.35

Bulletin 40 November, 1896

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

EIGHTH ANNUAL REPORT

BY CHARLES S. MURKLAND

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

CABOT SCIENCE LIBRARY
HARVARD UNIVERSITY
Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC A

AGRICULTURAL EXPERIMENT ST

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HON. FRANK JONES, Portsmouth.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Actin*
FRED W. MORSE, B. S., *Vice-Director and Chemi*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist culturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. SC., *Entomologist.*

ASSISTANTS.

RUEL S. ALDEN, B. S., *Assistant Agriculturist Superintendent.*
LEIGH HUNT, B. S., *Assistant Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of shire upon application.

Digitized by Google

EIGHTH ANNUAL REPORT

The eighth annual report of the New Hampshire College Agricultural Experiment Station, for the year ending November 1, 1896, is hereby respectfully submitted.

CHARLES S. MURKLAND,
Acting Director.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ended June 30, 1896.

RECEIPTS

Cash received from United States treasurer	$15,000.00

EXPENDITURES

Cash paid for salaries	$8,010.00	
labor	1,395.26	
publications	608.34	
postage and stationery	37.78	
freight and express	221.10	
heat, light, and water	495.76	
chemical supplies	165.02	
seeds, plants, and sundry supplies	324.27	
fertilizers	243.44	
feeding stuffs	1,040.41	
library	4.66	
tools, implements, and machinery	846.51	
furniture and fixtures	175.33	
scientific apparatus	258.07	
live stock	93.72	
traveling expenses	496.26	
contingent expenses	191.47	
building and repairs	392.60	
		$15,000.00

Digitized by Google

SUPPLEMENTARY STATEMENT

RECEIPTS

Cash received from the State Board of Agriculture for analysis of fertilizers .	$558.00
Cash received from sales of farm produce	623.67

EXPENDITURES

Cash paid for salaries . . .	$450.00
labor	623.67
chemical supplies . .	58.00
scientific apparatus .	50.00

We, the undersigned, duly authorized auditors of ration, do hereby certify that we have examined the accounts of the New Hampshire College Experiment the fiscal year ending June 30, 1896; that we have same well kept and classified as above, and that the the year from the treasurer of the United States ar have been $15,000.00, and the corresponding dis $15,000.00; for all of which proper vouchers are have been by us examined and found correct.

Also that the receipts from fertilizer analyses receipts, have been duly expended and vouched for, plementary statement.

And we further certify that the expenditures have for the purposes set forth in the act of congres March 2, 1887.

(Signed)

JOHN G. TALLA

CHAS. S. MURKI

Durham, N. H., August, 1896.

Digitized by Google

REPORT OF THE VICE-DIRECTOR AND CHEMIST

The membership of the Station council has continued unchanged throughout the year. The organization was changed May 1, 1896, by the appointment of F. W. Morse to the position of vice-director.

The position of clerk was made vacant May 1, 1896, by the resignation of Richard Fitzgerald and was filled June 1, by the appointment of Clement S. Morris.

Eight bulletins with a total of seventy-nine pages of printed matter have been published, as follows:

Bulletin 32, Studies of Maple Sap, by Fred W. Morse, 14 pages.

Bulletin 33, Two Shade-Tree Pests, by Clarence M. Weed, 7 pages.

Bulletin 34, Surface and Sub-Irrigation Out of Doors, by F. William Rane, 14 pages.

Bulletin 35, The Codling Moth and the Apple Maggot, by Clarence M. Weed, 7 pages.

Bulletin 36, Analyses of Three Common Insecticides, by Fred W. Morse, 3 pages.

Bulletin 37, Crimson Clover, by F. William Rane, 4 pages.

Bulletin 38, The Tent Caterpillar, by Clarence M. Weed, 15 pages.

Bulletin 39, The Army Worm in New Hampshire, by Clarence M. Weed, 15 pages.

The feeding experiments conducted during the year have been in charge of the writer and have included trials with milch cows, to determine the relative food values of different kinds of corn silage, and tests of the value of skim-milk as food for calves and pigs. The varieties of corn compared were Sanford, Leaming, and Mosby's Prolific, and further experiments with the same will be tried during the coming season. The trials with pigs and calves are also to be continued.

In the chemical laboratory, the most important work on account of time used, was the inspection of fertilizers for the secretary of the state board of agriculture. Two hundred and

Digitized by Google

sixty-seven samples of fertilizers were collected und
supervision of the secretary and the chemist. Th
represented one hundred and twelve distinct brands
and chemicals from twenty-four different manufa
was found necessary to employ extra assistance f
and Mr. F. D. Fuller and Mr. C. W. Vickery were
ten weeks.

In connection with the feeding experiments, numer
of silage and of milk were made. The amount an
the acid in the silage was also studied in contin
series of experiments extending through sever
Methods for determining potash in fertilizers and f
cattle foods were tested in coöperation with the As
Official Agricultural Chemists, upon samples furn
reporters.

The amount of miscellaneous work for the public
this year than last, which was due to the increase in
of samples of water sent to the station. One h
thirty-six miscellaneous samples were analyzed in
four of which were water and twenty-five milk
remainder included soils, ashes, and other fertilizin
dairy products, cattle foods, and insecticides.

Two dairy tests were conducted by an assistant of
ment, one with a herd competing for the prize off
Ayrshire Breeders' Association and the other with a
in coöperation with the Holstein-Friesian Associ
results of these tests are published by the respective

The chemist has been ably assisted in all the
department by Mr. Charles D. Howard. The work
departments of the station is summarized in th
pages.

FRED W.
Vice-Director and

Digitized by Google

DEPARTMENTS OF AGRICULTURE AND HORTICULTURE

The work of the year has been largely that of organization. The head of the department lectured at twenty-five different places during the past year, chiefly before grange organizations. The assistant in horticulture lectured at ten places, and the assistant in agriculture at two places.

Two bulletins have been published from this department, "Surface and Sub-Irrigation Out of Doors," No. 34, and "Crimson Clover," No. 37.

Two general exhibits of the college crops in both agriculture and horticulture were made at fairs, the State Grange fair at Tilton, N. H., September 7 to 10; Rochester fair, September 21 to 26; also sent one plate each of fifty-six varieties of tomatoes to the State Horticultural Society at Concord September 22 to 24.

I. Agriculture

Early in the year the new barn was made ready for use. All of the animals were subjected to the tuberculin test before they were transferred. The two new silos which had been previously filled were opened and furnished abundant green food until late in the spring. The whole herd consisted of twenty-six animals.

Feeding experiments were carried on under the direction of the chemical department.

A number of valuable animals have been added to the herd from time to time throughout the year. We now have representative Ayrshires, Guernseys, and Jerseys, also Durhams and grade Holsteins.

The following experiments have been planned and carried out during the present season:

1. Kainit as an absorbent and for increasing the value of manure, compared with gypsum and sawdust. The manure with each absorbent was kept separate. In the spring a plot of each was planted under the same conditions with various plants, to ascertain their respective values. The experiment has not been concluded.

CABOT SCIENCE LIBRARY
Digitized by Google

2. Fertilizing grass lands. In connection with th
Kali works, an experiment was undertaken to study f
question. Various forms and combinations of ferti
used in good sized plots. The experiment will req
time for completion.

3. Fertilizers on corn and potatoes to run one and
respectively, one half of each plot being treated with
dressing of lime.

4. Testing varieties of new forage crops. A num
newer agricultural plants that had never been grown
tion were sown in good-sized plots, that we migh
familiar with their behavior and value in this clim
varieties were Soja beans, spring vetch, lucerne, whi
seradella, crimson clover, sainfoin, Japanese mille
millet, spurry, Dwarf Essex rape, Jerusalem corn, K
white milo maize, teosinte, sacaline; also four variet
(Black Tartarian, Lincoln, American beauty, and whi

5. Growing roots. As with forage crops a few
grown in plots, viz., two varieties of Wahauka sugar
of carrots, long orange improved and white Belgian,
long red beet, and Lane's improved sugar beet, purpl
globe turnip and white French turnip, Jerusalem artic

6. Fertilizers for soja beans. One of the two ac
crop was set aside for a fertilizer experiment. It w
into quarter-acre plots and each was fertilized as fol
according to two different formulas recommended by t
chusetts station, one by a Delaware station formul
other by our own.

7. Skim milk as a fertilizer. Applied by surface
irrigation to various plants.

8. Soiling crops.

9. Variety test with three kinds of ensilage corn
Leaming, and Mosby's Prolific.

10. Pasteurizing milk and cream.

11. Testing crimson clover by sowing it each m
July until cold weather.

12. Killing out wire grass by plowing and sowing
buckwheat.

Digitized by Google

13. Forestry. During the winter vacation a piece of our college forest, which was thick with dead trees and underbrush, was measured out and thinned, according to modern methods of forestry. The data have been preserved and will be published in due time. A quantity of lumber sufficient for general use upon the farm was also cut and sawed during the winter.

In carrying on the work in this division, the head of the department has been ably assisted by Ruel S. Alden, B. S., farm superintendent.

II. Horticulture

November first, a greenhouse, 25x45, was completed and it has answered as a vegetable forcing-house as well as for general floricultural plants. This being the first house, its space has been in great demand. With it we were able to carry on much work that would have been impossible without it.

Early in the winter plans for the season's work were drawn up and presented to the Station Council for approval. The work has been carried out as follows:

1. Testing varieties of vegetables. This work was made to cover the subject in a general way, as a beginning. The amount of this work in the future will depend upon the apparent value of it.

The kinds of vegetables and number of varieties of each grown at the station this past season, were as follows:

Tomatoes, 56; early and late cabbage, 28; pole and bush beans, 50; cauliflower, 18; celery, 18; sweet corn, 32; musk melon, 36; onion, 9; early and late peas, 34; cucumbers, 11; beets, 8; lettuce, 10; water melon, 11; egg plant, 4; pepper, 3; carrot, 4; parsnip, 6; pumpkin, 4; spinach, 3; salsify, 2; asparagus, 4.

Also one or two varieties of each of the following: Parsley, rhubarb, kale, leek, Kohl Rabi, endive, okra, pop-corn, broccoli, sea kale, cardoon, cress, turnip, radish, etc.

2. Small fruits. A list of small fruits was ordered and set out last spring, as follows:

Strawberries, 47 varieties; gooseberries, 13 varieties; blackberries, 17 varieties; black raspberries, 18 varieties; red raspberries, 15 varieties; currants, 11 varieties.

Digitized by Google

The strawberries cover one-fourth acre, while the ot contain six plants of each variety. The plants, strawberries, were received in rather poor condition, shipment, and have not done well.

3. Plums. A test orchard of 40 different kinds was set out last spring, one tree of each variety.

4. Vineyard. Forty-four varieties of grapes, three each variety, have been set out.

5. Orchard fruits. We were unable to find time to with other tree fruits than plums this season. Most o scattered about the farm are Baldwins, a few Green dard, Nonesuch, Northern Spy, and Gravenstein. are old but this season were very productive. At t writing we have about three hundred barrels of app spring we received from the United States Departmen culture a donation of fifty-four scions of different v apples, two of pears, and three Persian peach trees. apples and pears were grafted on old trees, and mo have united and are growing.

A few varieties of quinces were also set out.

6. Potatoes. A list of eighty of the more promisin kinds, together with new varieties, was prepared for a v Enough seed to plant a fifty-foot row of each variet chased, and the varieties were all given as nearly a the same conditions in planting, spraying, cultiva harvesting. The results are being compiled for fu cation. These potatoes were exhibited at the Sta and Rochester fairs.

7. Irrigation experiments. In the spring, consid tention was given to mapping out some practical irr periments.

8. Fertilizers in the greenhouse. Considerable wor the past winter toward studying the subject of fer greenhouse soils, both in pots and boxes. One of objects was to find, if possible, a substitute in form mercial fertilizer for natural manures. This experi be carried on throughout the coming winter, as a the by one of our seniors in agriculture.

Digitized by Google

9. Floricultural work. The work in floriculture has been general except in the case of sweet peas. A study was made of eighty varieties of these.

10. A study of the difference in effect of muriate and sulphate of potash upon potatoes.

11. Preventing potato scab by the use of corrosive sublimate.

12. Planning to build a new greenhouse and potting-room. The plans have been completed and the buildings are in process of erection.

The work in this division has been accomplished through the able assistance of Mr. Leigh Hunt, B. S., assistant horticulturist.

F. WM. RANE,
Agriculturist and Horticulturist.

DONATIONS TO THE AGRICULTURAL AND HORTICULTURAL DEPARTMENT, NOVEMBER, 1895, TO NOVEMBER, 1896.

NAMES.	Number of Articles.	Kind of Donation.
A. T. Cook	5	New var. of vegetable seeds.
Currie Bros	4	New vegetable seeds and grain.
W. Atlee Burpee & Co	43	New vegetable and flower seeds.
Joseph Breck & Sons	36	New vegetable seeds.
H. A. Dreer	50	New vegetable and flower seeds.
A. W. Livingston & Sons	16	New vegetable seeds.
Perry Seed Store	1	New vegetable seeds.
James J. H. Gregory	18	New vegetable seeds.
Cole's Seed Store	5	New vegetable seeds.
J. L. Normand	1	Twenty Cassabanana seeds.
John A. Salzer Seed Co	4	Vegetable and flower seeds.
Peter Henderson & Co	18	Vegetable seeds.
Phœnix Nursery Co	2	New varieties grapes.
Sherman Nurseries (J. S. Kerr)	2	One new pear; one new plum.
D. Hill	50	Evergreens.
The Rogers Nursery Co	2	One new pear; one new plum.
W. W. Rawson & Co	2	Vegetable seeds.
Northwestern Seed Co	4	Vegetable and flower seeds.
C. H. Deitz	2	Varieties sugar beets.
Mr. E. Ray Shaw	3	Varieties Russia peas.
Mr Spaulding	1	Variety seedling musk melon.
E. P. Powell	19	Crosses of beans and s. corn.
Pomological Div., Washington, D. C.	59	Scions var. appl's, pears, peach's
T. O. Taylor	3	Corn and potatoes.

Digitized by Google

DEPARTMENT OF METEOROLOGY AND AGRICULTURAL ENGINEERING

1895–'96.

I. Meteorology

Regular observations of temperature, pressure, and weather have been carried on the past year, as begun the previous year and described in the last annual report. Weather flags have also been regularly displayed and during the summer months an extra set of flags has been loaned to Mr. Arioch W. Griffiths, who has displayed them from a tower on a hill near his residence at Packer's Falls. By the aid of a telescope he has read the signal-flags on the tower of the experiment station building, about two miles distant. The signals, as displayed in this locality, have been of service to an important farming section of this town, as well as to portions of Lee and Newmarket.

A few months since, a weather bulletin board was placed in position in the lower hall of the experiment station building, upon which the most important weather changes and reports are daily recorded for the benefit of the station staff.

Mr. James A. Foord, New Hampshire College, class of '98, has continued in charge of observations to the satisfaction of the department. During the summer vacation his duties were performed by Arthur Given, also of the class of '98.

The detailed record of observations taken will be found in the appendix.

II. Agricultural Engineering

This department has been called on by other departments of the station for a few surveys during the year but the most of its energy has been expended upon experimental road work. Grading and surfacing in different ways was carried on during portions of the summer upon a section of the highway, in front of the college property, about seven hundred feet in length. Through the kindness of Mr. M. H. Harlow, representing the Ingersoll-Sargeant Drill Co., a steam drill has been loaned the

Digitized by Google

college, and it has been used with much satisfaction through the season.

With the approval of the highway agents, a close watch has been kept upon the work done by them on the town roads, while the needs of these highways have been studied with the intention of reporting upon them at the close of the season. It is expected that the details of all this work, so far as they are of public interest, will be presented in bulletin form at a later date.

Popular talks on road construction and kindred topics have been given on seventeen occasions during the year.

C. H. PETTEE,
Meteorologist.

DEPARTMENT OF BACTERIOLOGY

During the year ending October 31, 1896, this department has carried on experiments on tuberculosis, on the pasteurization of milk and cream, and the use of pure cultures of bacteria for the ripening of cream. Considerable work has been done also in the study and treatment of the fungous diseases of the apple and potato.

H. H. LAMSON,
Bacteriologist.

DEPARTMENT OF ENTOMOLOGY

The four bulletins issued by the entomological department during the year have discussed at length six of the most destructive insects in New Hampshire, namely, the army worm, apple maggot, codling moth, sugar maple borer, tent caterpillar, and white-marked tussock moth. In addition to the work upon these subjects, the entomologist has given attention to a number of other injurious insects, bulletins upon which are in preparation. A summary of the more important insect injuries during the year will be found in the accompanying insect calendar for 1896.

Digitized by Google

Satisfactory studies of the life-histories of insects—studi which are essential to the best economic results—require caref and continuous attention from one whose time can be whol devoted to the subject. The entomological department nee an assistant for such work, as the college duties of the ent mologist require much time and frequent absences from tow During the past year occasional assistance has been render by students, especially Messrs. L. H. Kittredge and R. H Shaw. The former has been especially helpful in maki drawings for bulletin illustrations, and the latter in taking ph tographs for a similar purpose.

The Insect Record for 1896

The season of 1896, as far as insect outbreaks in New Hamp shire are concerned, was especially notable for the continuan of the attack of the American tent caterpillar[1] and an invasi by the army worm[2]. I have treated of both of these pes quite fully in recent bulletins, The Tent Caterpillar forming t subject of Bulletin 38, and The Army Worm, of Bulletin 3 The former insect was even more destructive than duri previous years and threatens to inflict still greater damage ne spring. Perhaps the most notable feature of the outbreak is t be found in the extending range of food plants. Not conte with the foliage of the apple and wild cherry, which from tim immemorial seems to have formed the staple diet of these cate pillars, they are now attacking many other trees, being force to this procedure because of the exhaustion of their ow natural food supplies.

A statement of this phase of the outbreak is published in th bulletin, already mentioned, and a number of illustrations of are there given. Figure 1 on next page shows the effect of te caterpillar attack upon the barberry, a plant which ordinaril does not suffer such injury. It is evident that concerted actio by communities is very desirable in subduing this pest which s greatly disfigures our highways, and so seriously injures ou orchards.

[1] *Clisiocampa americana.*
[2] *Leucania unipuncta.*

Digitized by Google

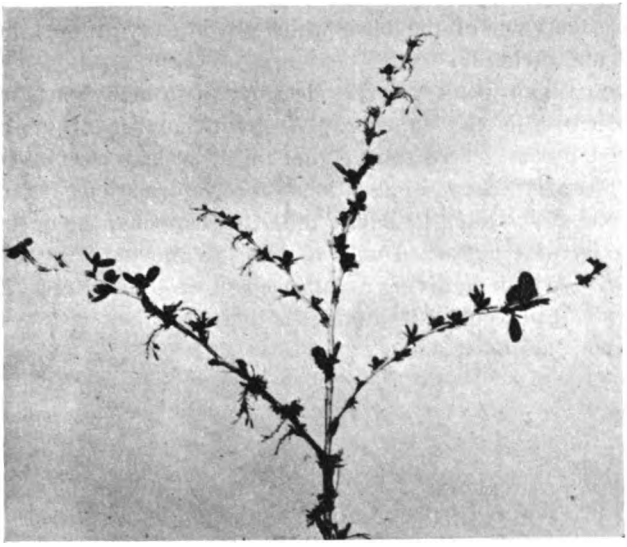


Fig. 1. A barberry branch defoliated by tent caterpillars.

In the tent caterpillar bulletin, the natural enemies of the insect are briefly treated of. Since its publication I have received a letter from Mr. W. F. Fiske, of Mast Yard, New Hampshire, from which I am glad to extract this statement: "I do not think you lay enough stress on the value of the chickadee as an exterminator of the tent caterpillar. I have repeatedly seen them tear open the cocoon for the pupa contained therein, and have credited them with a great many cocoons thus opened, which I have seen. If in the neighborhood of infested orchards, these birds were fed in the winter and proper nesting-places provided in the breeding season, it would be possible to colonize them there to the great benefit of the apple crop. A thick clump of spruces or other close-growing evergreens would be of good service to shelter the birds in the winter, and with good shelter and plenty of food they would not only be likely to colonize there in numbers, but it might also save the lives of individuals which would otherwise perish from exposure and lack of food." I am glad to

CABOT SCIENCE LIBRARY
CABOT SCIENCE HALL

Digitized by Google

endorse these sentiments and recommendations. realize the value of the birds which are already at fields and orchards.

The CANKER WORM was very destructive in many state early in the summer. A great number showed by the seared foliage that this pest had be We received many applications for information methods of subduing it, but as too often happens, t generally were not asked until too late to prevent injury. A bulletin giving a full account of the ins methods of preventing its injuries is in preparation, a to issue it at an early date.

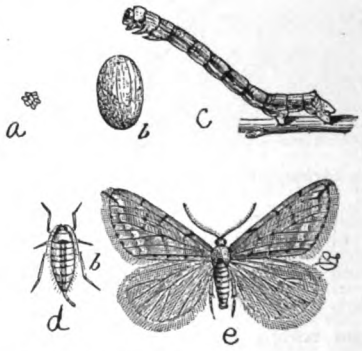


Fig. 2. The Spring Canker Worm

On account of the extraordinary abundance of crop this year there was comparatively little compl damage inflicted by the CODLING MOTH[1] and APPL There were so many apples that the insects were injure a small percentage of them and so were lit Both of these pests are treated of in Bulletin 35, issue

Some complaints were received during the seaso to pastures and meadows by the WHITE GRUB, the yo of the MAY BEETLE, or JUNE BUG.[3]

The life history of this pest, briefly sketched, i

[1] *Carposapsa pomonella.*
[2] *Trypeta pomonella.*
[3] *Lachnosterna fusca*, and other species.

Digitized by Google

brown beetles appear during May and June, and feed at night upon the foliage of various fruit and shade trees. They deposit small, whitish eggs among the roots of the grass. These eggs hatch into small, brown-headed grubs, that feed upon the roots about them. They continue feeding for two seasons, when they are full grown and form an oval cell in the soil and change to the pupa state, soon after transforming into beetles. The change to the pupa and beetle states generally occurs in the fall, the beetles remaining in the ground until the following spring, so that they are often turned up during late fall or early spring plowing.

This insect is one of the most difficult pests to fight of its class. It breeds especially in grass lands, and often ruins pastures and meadows, while crops planted on sod land are very frequently destroyed. There is much evidence to prove that with high farming and short rotations its injuries may largely be prevented. The parent beetles may be destroyed by spraying the trees on which they feed with London purple or Paris green. It will often pay, when land infested by these grubs is to be planted to strawberries or other crops which they are liable to injure, to have boys follow the plow and collect the grubs as they appear in the furrow. In this way a large amount of damage can frequently be prevented at very slight expense. The grubs in infested meadows may be destroyed by turning swine in the field.

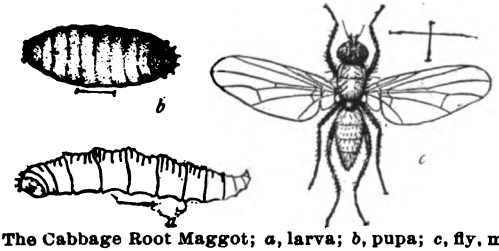


Fig. 3. The Cabbage Root Maggot; *a*, larva; *b*, pupa; *c*, fly, magnified.

Much injury was done during spring and early summer by the CABBAGE ROOT MAGGOT [1]—one of the most vexatious enemies of the gardener. The adult (Fig. 3 *c*) is a small, two-winged fly,

[1] *Anthomyia brassicae.*

CABOT SCIENCE LIBRARY
Digitized by Google

somewhat like the common house fly in general ap
which appears in the cabbage field soon after the pla
out, and deposits its eggs about the stems at the so
The little, whitish maggots soon hatch, and work
downward to the roots, which they attack, feeding
outer surface and thus making grooves, or borin
interior and hollowing out cavities. The effect of th
to remove the fibrous roots from the plant, so that w
up it resembles Fig. 4. In two or three weeks the m
come full-fed (*a*), and they change to the pupa st

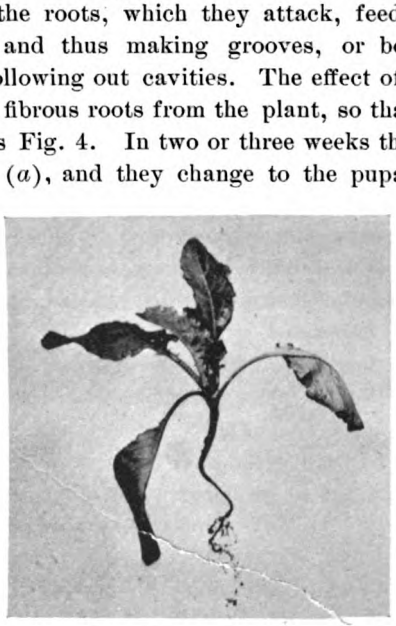


Fig. 4. Young Cabbage Plant denuded of roots by maggots. (

hard brown puparia (*b*), to emerge some days aft
adult flies. There are probably three or four br
season, and the insect apparently hibernates in each
later stages.

Considerable damage was reported early in the se
the work of various species of cut worms. The sam
conditions that favored the development of the ar
doubtless led to an unusual abundance of these clos
pests.

CLARENCE M. W
Enton

Digitized by Google

CABOT SCIENCE LIBRARY

Digitized by Google

Digitized by Google

Sci 1636.35

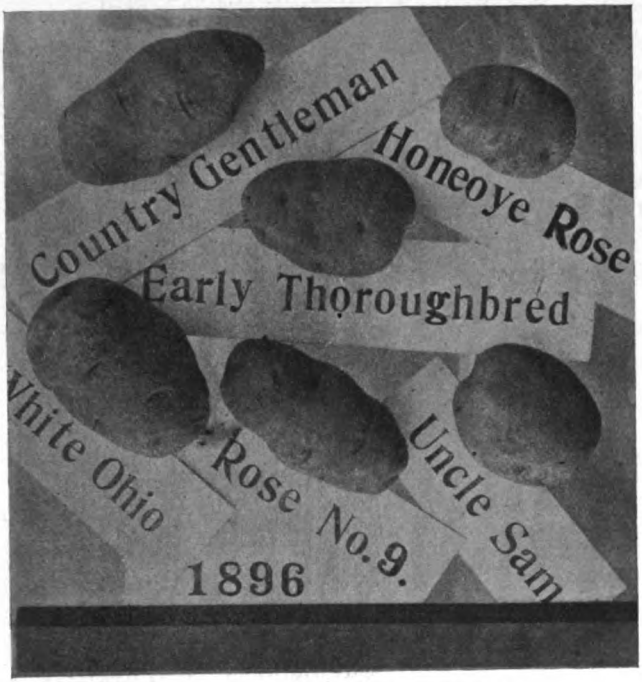
Bulletin 41 January, 1897

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

POTATOES

Varieties Fertilizers Scab



BY F. WM. RANE AND LEIGH HUNT

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

CABOT SCIENCE LIBRARY

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC AR

AGRICULTURAL EXPERIMENT STA

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HON. FRANK JONES, Portsmouth.

THE STATION COUNCIL

PRESIDENT CHAS. S. MURKLAND, A. M., Ph.
Director.
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist*
ticulturist.
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Agriculturist and*
turist.
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of
shire upon application.

Digitized by Google

EXPERIMENTS WITH POTATOES

BY F. WM. RANE AND LEIGH HUNT.

The potato is more commonly grown and used than any other vegetable. Scarcely any farm or garden is without them. Owing to this fact, growers have exerted themselves to get new varieties, many of which are identical with old ones, except that they are given other names. One person, for instance, finds that in a few years his Early Rose is superior to those of his neighbors, and therefore distinguishes it by a new name. Not all new varieties come about in this way, however, as we have some noted men who are worthy the title of potato-breeders or originators.

In taking up the study of the potato during the past season at this Station, we did not deem it necessary to enter into the whole subject in detail. Methods of culture, size of cuttings to use, various insecticides and fungicides recommended for both tops and tubers, fertilizers, etc., have been very fully experimented on in recent years by various authorities, and we have their valuable experience to begin with.

The work upon which this report is based is as follows, in outline:

1. Comparison of varieties.
2. Difference in effect of muriate and sulphate of potash upon potatoes.
3. Potato seed treated with corrosive sublimate as compared with that untreated.

1. COMPARISON OF VARIETIES

This being our first season's test, we desire to state that it is offered only that others may make use of it in comparison with their own experience. Just because a certain variety has given

Digitized by Google

a fair yield this year, it does not follow that it will do equal well next season. The causes of variation from year to year i the same variety cannot be due to the soil alone. It is n uncommon to be able to select two hills of the same variety sid by side, the one far more productive than the other.

Some varieties of potatoes, as the Rural New Yorker No. American Wonder, Early Rose, White Star, etc., have sufficie merit to gain a generally good reputation, while others becon valuable only locally. These facts are found out only by tri tests.

The accompanying photograph, Figure 1, will give a fair ide as to the characteristic, form, and appearance of each of th eighty varieties under test the past season. The number abov each potato refers to the same number before its name in th table. That specimen was selected that contained the mo decidedly typical characteristics of its variety.

Digitized by Google

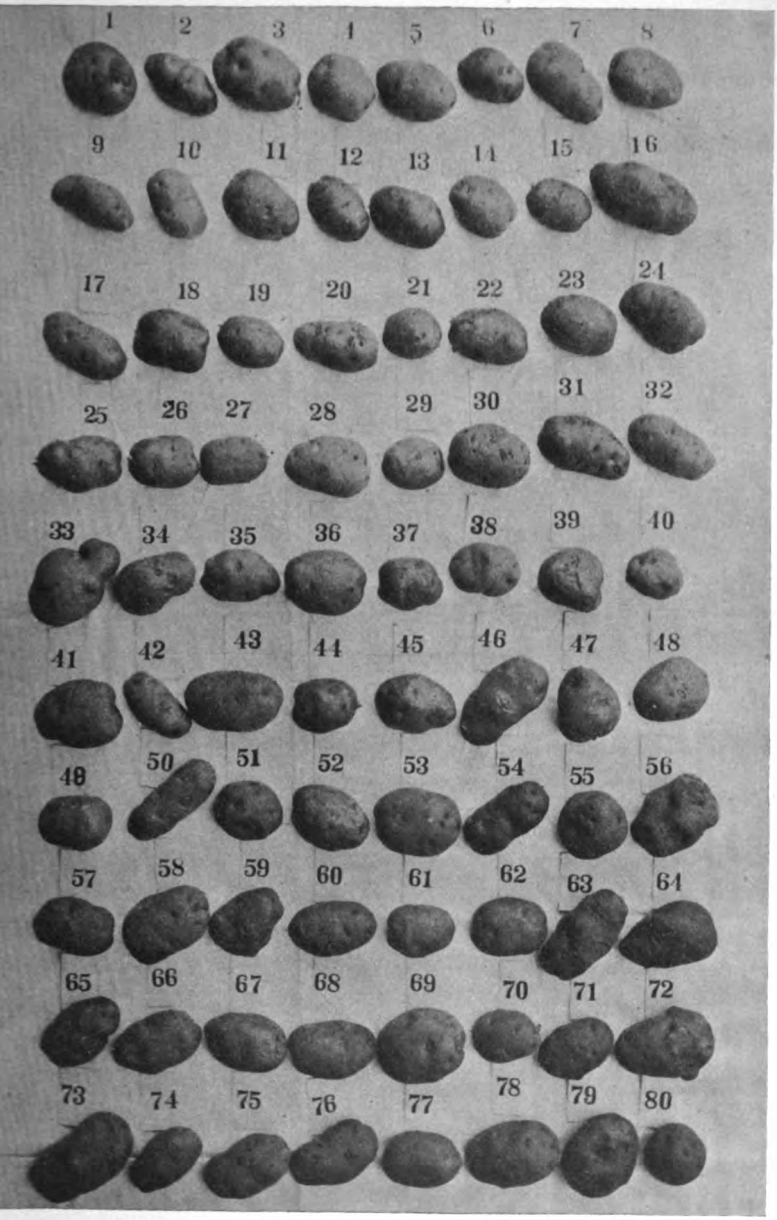


FIG. 2—Varieties of Potatoes.

Digitized by Google

TABLE I.—Comparison of Varieties of Potatoes. (Yield Per
culated from Forty-eight Feet of row, and Four Pounds

Number.	Variety.	Yield per acre.	Number.	Variety.
1	Uncle Sam (2 lbs. to 36 ft. of row)	214	41	King of the Roses..
2	American Wonder	240	42	Koshkonong
3	Banner	273	43	Late Puritan
4	Blush	272	44	Leonard's Favorite
5	Brownell's Winner	305	45	Maggie Murphy
6	Burpee's Extra Early	215	46	Money Maker
7	Burpee's Superior	209	47	Mill's Endurance
8	Bill Nye	195	48	New Queen
9	Bracey's Rising Sun	165	49	Ohio Jr
10	Carman, No. 1	230	50	Orphan
11	Carman, No. 3	239	51	Parker's Market
12	Champion	152	52	Polaris
13	Clark's No. 1	193	53	Peerless Jr.
14	Clay Rose	243	54	Prize Taker
15	Crown Jewel	223	55	Pride of Ireland
16	Country Gentleman	270	56	Queen of the Valle
17	Delaware	214	57	Quick Crop
18	Dewdrop Rose	258	58	Reeve's Rose
19	Early Harvest	248	59	Rochester Rose
20	Early Market	99	60	Rupert's Perfectio
21	Early Norther	244	61	Rutland Rose
22	Early Puritan	198	62	Rural New Yorker,
23	Early Rose	267	63	Rose, No. 9
24	Early Six Weeks	110	64	Seneca Beauty
25	Everitt	160	65	Sir William
26	Early Fortune	148	66	Somerset
27	Early Wisconsin	233	67	Salzer's World's Fa
28	Early Thoroughbred	220	68	Victor Rose
29	Freeman	174	69	Vick's Perfection
30	Farmer's Alliance	246	70	Vaughan
31	Good News	232	71	Vick's Advancer
32	Great Divide	224	72	White Star
33	Green Mountain	180	73	White Mountain
34	Harbinger	155	74	White Rose
35	Houlton Rose	305	75	Wilson's Fair Choi
36	Harvest Queen	287	76	Woodhull's Seedlin
37	Howe's Premium	140	77	World's Fair
38	Honeoye Rose	224	78	Woodbury White
39	Irish Cobbler	301	79	White Ohio
40	Irish Daisy	154	80	Governor Rusk

The potato plot was a good loam soil, grading into a
towards the south and east. A crop of millet was gr
the land in 1895, and potatoes in 1894. In the sprin
a light coating of cow manure and a heavy application
plete potato fertilizer were spread upon the plot. The
furrowed, and the potato seed cut in the ordinary ma
or three eyes to each piece, and two pieces dropped
feet. At the second hoeing, the rows were partly hille

Digitized by Google

the bugs appeared, the vines were treated three times with Paris green, and twice sprayed with Bordeaux mixture. The second and third time that Paris green was used, it was stirred into the Bordeaux mixture.

May and June were cool, dry months, and potatoes started slowly. While the rest of the season was sufficiently wet, there was no continuous moist, muggy weather to induce late blight and rot.

TABLE II.—THE FIFTEEN HEAVIEST YIELDERS, IN ORDER OF PRODUCTIVENESS.

Number.	Varieties.	Yield per acre.
58	Reeve's Rose	453
74	White Rose	399
69	Vick's Perfection	394
80	Governor Rusk	375
78	Woodbury White	373
65	Sir William	354
57	Quick Crop	342
76	Woodhull's Seedling	329
70	Vaughan	324
73	White Mountain	323
43	Late Puritan	316
56	Queen of the Valley	315
41	King of the Roses	310
44	Leonard's Favorite	307
72	White Star	306

NOTES ON VARIETIES.

1. *Uncle Sam* (Henderson).—This variety was first put upon the market last season. The introducers claim it to be a heavy yielder, of uniform shape and size, and superior in cooking qualities, which claims seem to be well-founded—from our results the past season. It made strong, healthy vines, continued to grow late, and yielded well. The tubers were oval in shape, of handsome appearance, and but few small ones. Skin mostly a clean white, with a somewhat russetty appearance. It ripens with Rural New Yorker. All things considered, this potato gives great promises for the future. Mr. H. N. Hammond, a seedsman and potato-grower of Michigan, says: "Heretofore, I have considered the Carman, No. 3, the most perfect of all late varieties I have tested, but from one season's trial, I must admit

CAROT SCIENCE LIBRARY
Digitized by Google

that Uncle Sam even surpassed Carman, No. 3, in wonder growth, in yield, and last, but not least, in quality."

2. *American Wonder.*—Within the past few years, this varie has been very generally grown. From general reports, it stan up well in productiveness. The vines are very vigorous, and not blight readily. The potatoes are white; medium to larg quite uniform in size, and regular in shape. Its yield at t Michigan Station, in 1895, was 379 bushels, with an avera yield for four years of 242 bushels. At the Ohio Station, in 18 it yielded 276 bushels, with an average yield for two years 222 bushels. Our yield the past season was 240 bushels.

3. *Banner* (Livingston).—This potato is of very pleasi appearance. It does not appear to have the fixed character tics that mark other stable varieties; the eyes are both shall and deep, and the color not sufficiently uniform. It was abo the average in productiveness.

4. *Blush.*—A very vigorous, red and deep-eyed variety. Fai productive, and medium early; round to oblong in shape.

10. *Carman, No. 1* (Thorburn, 1894).—This variety was int duced in 1894, and is one of Carman's seedlings. The vin were large, with far spreading branches, making a thick foliag The tubers were numerous but not large, running from mediu to small, and usually oval in form, squaring off at the ends. T eyes were shallow; color, white. It ripened in midseason. greatest drawback seemed to be its setting more tubers th could be matured of fair size. It is reported by others as o yielding and giving better size than the Rural New Yorker, No.

Carman, No. 3 (Thorburn, 1895).—This variety is widely a favorably known, because of its very general introduction a growth in 1895. It is another seedling of Mr. Carman's, a resembles in appearance of growth the Rural New Yorker, No. with purple sprouts, purple blossoms, and dark-colored stall It is a late variety. The shape is somewhat longer than that the Rural New Yorker, No. 2. There were but few small tube

14. *Clay Rose.*—This potato is a late red variety. It claimed to be specially adapted for stiff clay soils. It was sm and short in shape, and eyes rather deep. Not promising.

16. *Country Gentleman* (Jerrard, 1896).—This potato w

Digitized by Google

introduced the past season by Mr. Jerrard, of Caribou, Me. It grew very well during the fore part of the season, but blighted early. The tubers were not very large, and of various shapes. It was a medium late, of rose color, with shallow eyes. Forty-three per cent. scabby.

21. *Early Norther* (Jerrard, 1892).—A medium early market variety. It resembles the Early Rose in general appearance. Was not very uniform in size and form this season.

28. *Early Thoroughbred* (Maule, 1896).—This newly introduced variety does not seem to have any points of special merit to recommend it. It may need a soil different in some respects from ours. The tubers were generally small, oblong, and not attractive. It belongs to the Rose family.

29. *Freeman* (Maule, 1891).—This variety is very highly flavored; tubers white; shape, round to oblong. It seems to require high culture. Potatoes too small for marketable purposes.

38. *Honeoye Rose* (Dibble, 1896).—Mr. Dibble offered this for the first time the past season, and says it is a seedling of the Victor Rose, which in turn was a seedling of the Reeve's Rose. It did not yield as well as either of its ancestors with us last season. The size was good, having but few small tubers; eyes, shallow. Promising.

41. *King of the Roses.*—A medium early, strong-growing variety, of good rose color; oblong in shape, resembling Reeve's Rose quite closely. Rather too large a proportion of small tubers. Good yield. Nine per cent. scabby.

43. *Late Puritan.*—A late, yellowish-colored variety, of vigorous habits of growth. The tubers long, uniform in size and regular in shape; fine appearance.

44. *Leonard's Favorite.*—Was fairly productive, of rose color, and with long, slender, spreading growth. A good early variety.

45. *Maggie Murphy* (Vick).—A midseason variety, pink in color, and quite widely grown. Its yield was light here this past season, but the tubers were mostly of marketable size. In some sections of the state it is reported as not being a good keeper, and of poor quality. Generally, it seems to be a favorite.

46. *Money Maker* (Dibble, 1895).—A long, white, cylindrical

Digitized by Google

potato, with a tendency to have protruding knobs. A rat
large proportion of small potatoes.

50. *Orphan.*—A fine, long, slender, smooth, white pota
shallow eyes. Uniform in shape, size, and color. It present
good appearance.

51. *Parker's Market* (Jerrard, 1895).—Oblong to cylindrica
shape. Red color; claimed to withstand rot, and adapted
heavy soil. Medium size, but too many small tubers.

53. *Peerless, Jr.*—Flat and rectangular in shape. Eyes sl
low, and mostly at the tip end of tuber. All of good size.
sembles the Rural New Yorker, No. 2.

57. *Quick Crop.*—A potato of the Hebron type, althou
somewhat darker in color. Smooth, oblong, and of fair si
yield, good; a promising variety. It is grown mainly in
West.

58. *Reeve's Rose.* This variety is grown extensively by
Jersey and Long Island truckers. It was the most product
grown at the Station last season, but the percentage of la
tubers was not as great as of some others; not so producti
It is rather deep-eyed, pink in color, slender and oblong in sha
and second early in ripening. Strong, vigorous tops.

63. *Rose, No. 9* (Dibble).—A late, red variety, introduced
past season by the Dibble Seed Company, who claim for
"Our latest and best late red variety for general field cultur
In their field test of 207 varieties, covering two years, t
showed the best average yield of the red sorts. Its yield h
was among the lowest. The tubers were of good size, but
greatest objection was its tendency to grow bumps, or protrud
eyes upon the surface, and to scab readily. It may overco
these objections upon further trial.

65. *Sir William.*—A vigorous and prolific late variety. It
a strong grower, with vines erect and over three feet in leng
Color, white; long, square ends. Its being late to mature fr
it from the early blight. It stood sixth in rate of yield,
much nearer first in production of marketable potatoes. We
much pleased with it thus far. We find it highly spoken of
those who have tried it. Prof. W. J. Green, of the Ohio Exp
ment Station, after having grown it on different kinds of so

Digitized by Google

for two years, says: "It is an almost ideal potato, both for home use and for market." Dr. I. B. Chamberlain, of the *Ohio Farmer*, claims it to be the best potato he ever grew. It was about twenty per cent. scabby with us this season.

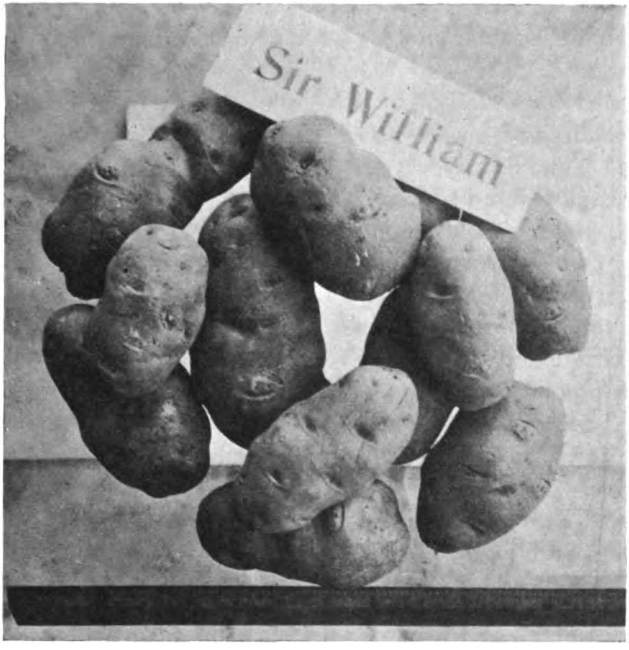


FIG. 2.—Sir William Potato.

66. *Somerset* (Jerrard, 1895).—A rose-colored variety, ripening midseason, eyes rather deep. Only average in productiveness last season. The tubers run evenly, and make a good appearance. Quality excellent.

69. *Vick's Perfection*.—A second early variety, productive, color white, shape irregular, eyes both deep and shallow; no uniformity. A good many small tubers; sixteen per cent. scabby.

70. *Vaughan*.—Numerous tubers set, but did not reach sufficient size. Blighted early; twenty-seven per cent. scabby. Beauty of Hebron type.

CABOT SCIENCE LIBRARY
Digitized by Google

72. *White Star.*—This old variety stood well in the giving a yield of 306 bushels per acre. The tubers were l evenly cylindrical, and of a clean, white appearance. V rather slender and long, of late growth; four per cent. scabl

73. *White Mountain.*—Healthy, vigorous grower; stro resistant to early blight. Well-proportioned, large potat twelve per cent. scabby, and these among the smaller tub Yield good.

74. *White Rose.*—The tubers were long and cylindrical, very light pink, shallow eyes. A medium, second early pot of the White Star type; yield heavy, but too many small tub The largest were not large.

79. *White Ohio* (Vick, 1896).—This is a seedling of Early Ohio, only white in color. The introducers claim it t the earliest white potato grown. It did not prove superior us, although its general appearance was good. The yield an average one, tubers flat and oblong in shape, and contain a fair proportion of small ones. Shallow eyes.

80. *Governor Rusk.*—A potato of nice appearance, smo long and cylindrical in shape, of reddish color, and very ductive. The tubers averaged good size; the vines were str and large; eighteen per cent. scabby. A desirable variety continues to do as well as this season. Ripens with the sec early varieties.

2. MURIATE VS. SULPHATE OF POTASH.

It has been thought in recent years that although muriat potash is the cheaper form of the potash salts, for the amo of fertilizer it contains, it nevertheless has some properties t render it undesirable for a number of vegetables, among th potatoes. Experiments in Germany and at the Massachus Station, point very conclusively to this fact. We tested th two forms of potash on each of the eighty varieties of potat grown the past season, one half of each row being treated w sulphate, and one half with muriate. The other forms of tilizer used, as phosphoric acid and nitrogen, were the sa throughout. The results were as follows:

Of the eighty varieties, forty-seven gave a heavier yield w

Digitized by Google

sulphate, and thirty-three with muriate of potash. The total yield, however, was in favor of the muriate. The total weight of those grown with sulphate was 1,978 pounds and 7 ounces, and with muriate, 1,996 pounds and 9 ounces—making a difference of 18 pounds and 2 ounces in favor of the latter.

In comparing the percentage of large and small potatoes, there was but a slight difference. The weight of the large, or marketable, potatoes with sulphate was 1,567 pounds, and with muriate, 1,586 pounds, 19 pounds in favor of the latter. The small potatoes yielded 411 pounds with sulphate, and 409 pounds with muriate.

From the data obtained from this single year's test, little preference is shown for either of these forms of potash, as far as yield is concerned.

3. CORROSIVE SUBLIMATE TREATMENT FOR POTATO SCAB.

Most of the trials in treating the potato seed before planting with corrosive sublimate have proved it to be beneficial. During the past season, we tested its efficiency upon each of the eighty varieties grown. The soil, having been used for a potato crop two years previously, was inoculated with the disease. One half of each variety was placed in a coarse sack, and after soaking one and one-half hours in a solution, in the proportion of two ounces of corrosive sublimate to sixteen gallons of water, was taken out and drained off; then cut and planted. Throughout the fore part of the season the soil was comparatively dry, but during the remainder was very moist, and offered exceptionally favorable conditions for scab development, as it is well known that moisture favors its growth.

From the data secured, we arrive at the following results: Two varieties, Nos. 60 and 68, were free from scab with both treated and untreated seed. Two varieties, 3 and 58, showed the same percentage of scab under both conditions. Sixty-two varieties favored the treatment, while the remaining fourteen did not. The total average for those treated was $24\frac{4}{8}$ per cent. of scabby potatoes, while for those untreated it was $35\frac{1}{2}$ per cent. The efficiency of the treatment, therefore, was $10\frac{1}{8}$ per cent. Considering the fact that the soil was infected, and that

CABOT SCIENCE HALL
CABOT SCIENCE LIBRARY

Digitized by Google

some manure was used, while the season also was favorable f scab development, the results seem marked in favor of corrosi sublimate. If applied to the seed of a variety that gave yield of 300 bushels per acre, even under the unfavorab conditions mentioned, there would be 30 bushels more fr from scab than otherwise. This treatment is very general accepted as being sufficiently practical for recommendation.

SUMMARY REMARKS.

1. This being the first season's test, we hesitate recor mending many of the varieties.

2. We feel little hesitancy, however, in recommending su as White Star, Rural New Yorker No. 2, American Wond Carman No. 3, Governor Rusk, and Sir William, as these ha been reported on favorably from so many sections.

3. The fifteen varieties giving the heaviest yield, in order productiveness, are given in Table II.

4. The ten varieties giving the least yield, in order, beginni with the poorest, are: Early Market, Early Six Weeks, Mil Endurance, Howe's Premium, Early Fortune, Rose No. Champion, Irish Daisy, Houlton Rose, and Bracey's Rising Su

5. The average productiveness of all varieties per acre w 244 bushels, the lowest being Early Market with 99 bushels, a the highest, Reeve's Rose, with 453 bushels.

6. There was very little difference in the effectiveness muriate and sulphate of potash on potatoes. One appears be about as effective as the other.

7. Those treated with corrosive sublimate gave on an avera $10\frac{1}{8}$ per cent. less scab than those untreated; or about bushels to the acre.

8. After we have selected a sufficient quantity for seed pu poses, we shall be pleased to send, at the expense of the receiv a limited quantity (a few potatoes) for test purposes, provid the person receiving them has had experience in potato growin and will report his results as soon as the crop is harvested.

Digitized by Google

CABOT SCIENCE LIBRARY

Digitized by Google

Digitized by Google

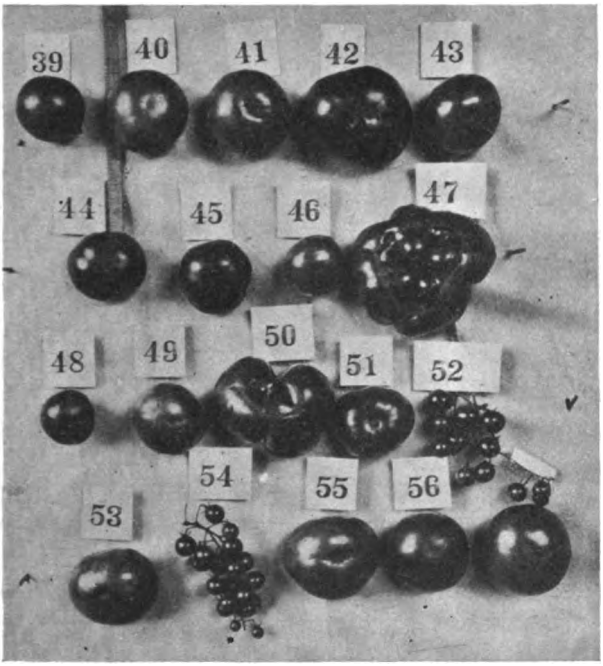
LIBRARY
of
H. S. JACKSON
Sci 1636.35

Bulletin 42 February, 1897

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

I. TOMATO GROWING IN NEW HAMPSHIRE
II. NOTES ON TOMATO BREEDING



BY F. WM. RANE AND LEIGH HUNT

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

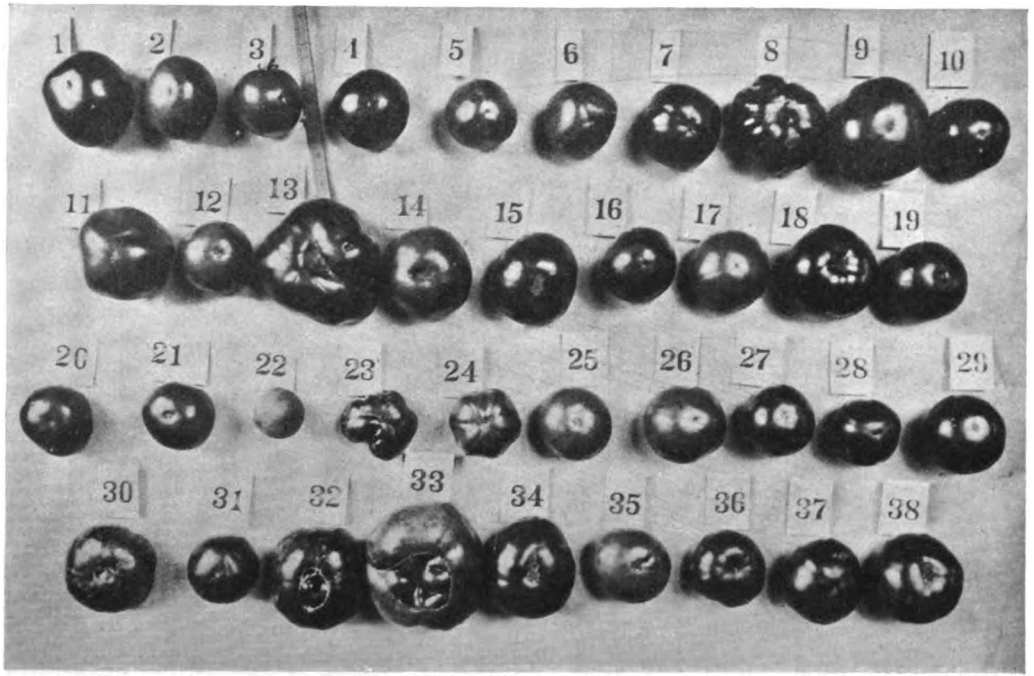


FIG. 2. Tomatoes photographed Sept. 14, 1896 (also Fig. 1, cover). See Table 1 for name.

HARVARD COLLEGE LIBRARY NOV 15 1935
The Station

Digitized by Google

I. TOMATO GROWING IN NEW HAMPSHIRE

F. WM. RANE AND LEIGH HUNT

At the Tilton and Rochester fairs, last fall, it was evident that tomato growing was well understood by many gardeners, especially by those who made exhibits. Many were able to name at sight a large proportion of our fifty-six varieties on exhibition. Not having fully completed our notes at that time, we were unable to state the average yield, and much of the information asked for, especially regarding the newer varieties. The office of this bulletin is to present the results of our study of the varieties named during the past season. Our deductions and notes apply only to our New Hampshire conditions. The varieties best suited to our state are those having an early maturity, ripening the bulk of their fruit before September.

SOIL AND CULTIVATION

The soil of the tomato field was a good loam, practically level. A crop of millet was grown upon the land in 1895, and potatoes in 1894. In the spring of 1896 a light coating of cow manure, and a heavy application of a complete tomato fertilizer were used. The plants which were started from seed in the greenhouse, March 16th, had been transplanted twice, once from the seed boxes into trays, two inches apart each way; and again into the cold frame, six inches apart, thus giving them a stocky growth. They were transplanted into the field May 25th and 26th, in rows five feet apart, the plants three feet apart in the row; or, at the rate of 2,904 plants to the acre. Ten plants of each variety were selected upon which to base the experiment.

The land was cultivated frequently until the plants were of fair size. The method of training was to tie each plant to an ordinary bean-pole sufficiently to keep it from the ground. This necessitated a slight amount of pruning to improve the

Digitized by Google

conditions for ripening. May and June were cool, dry mon and the tomatoes started slowly. While the remainder of season was sufficiently wet, there was no continuous mu weather to induce the growth of fungous diseases.

The fruit was picked three times a week, on Mond Wednesdays, and Fridays, and at each picking the num total weight, amount of rot, etc., were tabulated for e variety. The photographs show a single specimen of e variety at nearly the close of the season. They were sele September 14th. While in some instances the size is slig below the average, in most cases the selection is a fair re sentative of its variety.

TABLE I.

Comparison of Varieties. Ten Plants Used as the Basis of Estima

Number.	VARIETY NAME.	Average yield per plant.	Date of first ripe fruit.	Average weight of ripe fruit.	Per cent of rot.	Average weight of green fruit per plant, Sept. 24th.	Seedsm
		Lbs.		*Oz.*		*Lbs.*	
1	Large Red Olive Cross	7.1	Aug. 10	2.6	3	10	Landret
2	Mixed Red and Purple Cross	6.4	" 12	4	1	9.8	"
3	Scarlet Cross	6	July 24	3.6	1	8.7	"
4	Large Purple Olive Cross	6	Aug. 10	5.3	4	9.6	"
5	Three Celled Cross	4.7	" 3	3.2	1	9.5	"
6	Two Celled Cross	5.2	" 10	2.6	4	13	"
7	Ten Ton	8.9	" 10	3.9	1	5.4	"
8	Early Richmond	14.2	" 7	4.9	2	3.3	"
9	Virginia Corker	8.3	" 12	2.8	2	9.8	"
10	Dwarf Aristocrat	10.9	July 24	2.8	3	4.7	Livings
11	Buckeye State	3.5	Aug. 19	6.8	11	8.9	"
12	Early Acme	11.2	" 3	4.2	6	5.3	"
13	Stone	8.9	" 12	7.2	.7	8	"
14	Beauty	11.2	" 7	6	4	4.5	"
15	Early Michigan	12.6	" 10	6.4	.7	6.9	Ferry.
16	Optimus	8.7	" 10	5.	1	5.4	"
17	New Tomato, No. 105	9	" 10	4.4	1	6.5	Jo'n.&S
18	New Liberty Bell	10.4	" 7	6	2	3.9	"
19	The Fortune	8.1	" 7	4.5	1	2.8	"
20	Brinton's Best	11.4	" 10	5.5	2	2.7	"
21	Ignotum	8.1	July 29	3.9	4	3.2	"
22	Red Peach	3.3	Aug. 12	2	.8	5.8	Vaugha
23	Earliest of All	9.1	July 16	2.2	2	.7	"
24	Thorburn New York	7.2	Aug. 7	3.3	15	4.6	Thorbu
25	The Waldorf	10.1	" 7	4.8	8	6.9	"
26	Autocrat	9.6	" 10	4.8	1	6.7	"
27	Democrat	8.6	" 10	6.9	2	6	"
28	Conference	10.6	July 29	3.4	.6	3.1	Farquh
29	Faultless Early	8.8	" 24	4.5	3	2.7	"

Digitized by Google

TABLE I.—*Continued.*

Comparison of Varieties. Ten Plants Used as the Basis of Estimation.

Number.	VARIETY NAME.	Average yield per plant.	Date of first ripe fruit.	Average weight of ripe fruit.	Per cent. of rot.	Average weight of green fruit per plant, Sept. 24th.	Seedsman.
		Lbs.		*Oz.*		*Lbs.*	
30	Bright and Early (large)	16.3	July 24	4.8	3	.....	Farquhar.
31	President Cleveland	16.4	" 29	2.7	1	.....	"
32	Crimson Cushion	14.9	Aug. 7	7.7	3	.....	Henderson.
33	Ponderosa	18.6	" 1	7.3	4	.....	"
34	Belmont	16.6	July 24	4.2	1	.....	Breck.
35	Acme	11.9	Aug. 7	6	2	5.5	"
36	Early Leader	15.3	July 16	3	5	.2	Vick.
37	McCullom's Hybrid	11.3	" 24	4.8	4	4.6	"
38	Puritan	10.4	Aug. 12	5.7	5	7.7	Rawson.
39	County Fair	8.6	July 18	3.3	2	4.1	Buckbee.
40	Imperial	10.9	" 24	5.2	2	5.2	Burpee.
41	Fordhook First	9.7	" 8	4.2	3	3.8	"
42	Chenery's Early	10.8	" 24	4.6	6	3.8	Sch.& Fottler
43	Thorburn Long-Keeper	11.7	Aug. 4	4.2	2	5.5	"
44	Red Cross	11.2	" 7	4.6	3	2.5	"
45	Red Bird	13.9	July 29	3.9	2	.9	Cooke.
46	Fifty Days the Earliest	13.8	" 24	1.8	.3	1.7	Salzer.
47	Morning Star	12	Aug. 18	3.1	3	4.6	"
48	Bright and Early (medium)	13.8	" 18	2	.5	1.2	Dreer.
49	Bond's Early Minnesota	11.5	" 10	2.2	.7	2.4	"
50	Wisconsin Climbing	8.8	July 27	7.3	3	2.2	May.
51	First of All	13.2	" 16	4.4	2	1	"
52	Clustered Small Red	1.2	" 29	.....	2	.....	F. W. Brooke
53	Large Yellow	3.7	" 24	3.7	2	.....	"
54	Large Red (clustered)	2.5	" 29	.....	2	.....	"
55	Perfection	8.7	" 29	4.1	3	4.6	H. Barnard.
56	Dwarf Champion	3.5	Aug. 21	2.1	2	9.6	Biedermann.

NOTES ON VARIETIES

Nos. 1, 2, 3, 4, 5, and 6 are Landreth's crosses, the names of which can be found in Table I. They are of interest from the standpoint of plant-breeding, but are too unstable for general recommendation. All were comparatively late and yielded below the average.

7. *Ten Ton.*—Smooth, crimson tomato, of fair size, good shape, and moderate firmness. Ripens slowly after first coloring.

8. *Early Richmond.*—No longer deserves planting; two weeks later than other better varieties. Good size, productive, ripening rapidly after it has once turned; but is a rough, flat-

Digitized by Google

tened, much-ribbed fruit. Its irregularities make broken in handling.

9. *Virginia Corker.*—Rather late and ripens good form and color; firm. Good for close o green fruit.

10. *Dwarf Aristocrat.*—Bright red fruit, wh ripen early but not in quantity until late. Fruit s apple-shaped, small to medium; vines two to thr of a very dark green, massive foliage.

11. *Buckeye State.*—Except for a very late fru less. Large vines and fruit of good size and form, purple in color. Bad tendency to rot.

12. *Early Acme.*—Probably a selected strain f Acme. Though similar in all respects, it is ra Ripening earlier in the season, it also ripens n nothing gained. Good size and shape, prolific.

13. *The Stone.*—An excellent tomato in form, tity, and size, good keeper, solid, skin strong, s regularly throughout the season. Late and strong

14. *Livingston's Beauty.*—One of the most tomatoes grown; medium early, continuing very l or purple fruit, of a very smooth, solid, and de Keeps and ships well; good quality, vines stron medium size. Prolific.

15. *Early Michigan.*—Not to be called an e others had yielded fifteen or sixteen pounds of fru ripened. Smooth, good shape, rather large, proli

16. *Optimus.*—Very uniform in color, size, good, productive, middle-season tomato.

17. *New Tomato, No. 105.*—Large, late vines, good size, fairly abundant, firm, smooth, red. K

18. *New Liberty Bell.*—Medium to late, fai and somewhat flattened; tendency to remain g crack at stem end.

19. *New Fortune.*—Smooth, uniform in size good quality, with vines of a rugged, strong growt

20. *Brinton's Best.*—Middle-season variety, fair size, good quality.

Digitized by Google

21. *Ignotum.*—Large, smooth, solid, sour, productive, and well-known variety; tendency to rot.

22. *Red Peach.*—Good for its kind,—useful only for private gardens.

23. *Earliest of All.*—Slender vines, bearing a good crop of a most inferior, rough, ribbed fruit, with one side ripe and one green. Ripens in quantity early in season, which is all that can be said for it.

24. *Thorburn's New Yorker.*—A medium tomato in all respects; hexagonal in shape, red and purple, considerable rot at blossom end. Tendency to crack before ripe.

25. *The Waldorf.*—Very good; medium to late, smooth, productive, and firm; desirable shape and size.

26. *Autocrat.*—Fair, not as uniform in size as Beauty, Champion, etc., but of good average, desirable firmness and shape, mild flavor, prolific.

27. *Democrat.*—Larger and not as smooth as 26, but much like it.

28. *Conference.*—Smooth, medium size, good quality, firm and productive.

29. *Faultless Early.*—A good, smooth tomato, uniform in size, color, and shape; not particularly early, but preferable to 23.

30. *Bright and Early.*—Large and irregular; does not ripen uniformly. Of no use.

31. *President Cleveland.*—Not uniform in size, color, or shape; good quality, fairly firm, prolific.

32. *Crimson Cushion.*—Uniformly large, irregular, quite badly cracked and spotted with green; productive.

33. *Ponderosa.*—Ripens slowly; huge, irregular, double and single fruits; not suitable for table use.

34. *Belmont.*—Scarlet, round, smooth, solid, early, very productive, and of good quality; ripens very uniformly throughout the season.

35. *Acme.*—A dark red, medium-sized, smooth, solid, and well-known, reliable variety.

36. *Early Leader.*—Very similar to 23, very little better; of no use.

Digitized by Google

37. *McCullom's Hybrid.*—No uniformity in shape, or quality of fruit; productive.

38. *Puritan.*—Scarlet, medium to late, good si variable.

39. *County Fair.*—One of best grown; early fruit solid, dark red, smooth, good quality, ripeni throughout the season. Sturdy, dark green vin Dwarf Aristocrat.

40. *Imperial.*—Not up to standard this season size. Some cracked; seed mixed, perhaps.

41. *Fordhook's First.*—Tall growing vines, ye liest to produce good fruit. Crimson, round, solid, good flavor; keeps well. One of very bes continues good till frost.

42. *Chenery's Early.*—A good crimson vari equal to 41. Fruit fairly solid, of uniform shape.

43. *Thorburn Long-Keeper.*—Good size, firm good keeper, productive.

44. *Red Cross.*—Medium size, middle and late good shape and quality.

45. *Red Bird.*—Medium to small, good quali not very solid; productive.

46. *Fifty Days the Earliest.*—A red tomato c solid, round, smooth, and uniform in all respec early and productive. Good for shipping, if siz sible.

47. *Morning Star.*—Another of the Ponderosa large, rough, and undesirable.

48. *Bright and Early.*—Very similar to 46 later.

49. *Bond's Early Minnesota.*—Dark red, s hard, and of good quality, productive; not early. as 46 and 48.

50. *Wisconsin Climbing.*—Large, double ton and undesirable.

51. *First of All.*—Fairly smooth, with tendenc top as season advances. Probably identical v Prize.

Digitized by Google

52. *Clustered Small-Red.*—Curiosities; inferior in flavor, late, and apt to crack before ripening.

53. *Large Yellow.*—Medium size, smooth, good quality, but ripens very slowly, with light yields. Inferior to Lemon Blush or Golden Queen.

54. *Large Red Clustered.*—Same as 52, only somewhat mixed with yellow.

55. *Livingston Perfection.*—Early, of good size, uniform in color and shape; one of best for home gardens. Softer than Beauty.

56. *Dwarf Champion.*—Short, stocky vines, yielding good crops of smooth, purple, solid fruit; stands shipping well. Desirable for any purpose; are the very best for spring plant trade.

SUMMARY

1. The varieties best suited to New Hampshire are those having an early maturity, ripening the bulk of their fruit by September.

2. The following varieties we would place upon the rejected list: Early Richmond, Earliest of All, Bright and Early, Ponderosa, Early Leader, Morning Star, Wisconsin Climbing, and Large Yellow.

3. All of the Landreth crosses, together with Buckeye State and Virginia Corker, are too late for this climate.

4. The varieties making the best general showing were: Belmont, Early Michigan, Acme, Brinton's Best, Beauty, Red Cross, Waldorf, Fordhook's First, Stone, and County Fair. These are named in order of productiveness.

5. The varieties making a fair showing were: Red Bird, Long-Keeper, Dwarf Aristocrat, Chenery's Early, Conference, Puritan, Autocrat, No. 105, Optimus, Perfection, Ignotum, Fortune, and Dwarf Champion. Also given in order of productiveness.

6. The following varieties were found to possess some objectionable features: President Cleveland, Crimson Cushion, First of All, McCullom's Hybrid, Imperial, New Liberty Bell, Faultless Early, and New York.

7. A distinct type of tomato is found in the three varieties: Bright and Early, Fifty Days the Earliest, and Bond's Early

Digitized by Google

Minnesota. While below the average in size, as shown is Nos. 48, 46, and 49, respectively, in the photograph, they are smooth, uniform, productive, and very desirable for home use, if not for the market.

8. Varieties 22, Red Peach, 52, Clustered Small Red, and 54, Clustered Large Red, are simply novelties, and of comparatively little use except for preserving and pickling.

II. NOTES ON TOMATO BREEDING

BY F. WM. RANE

There is probably no plant we have so much literature upon, and that has been studied so thoroughly from the standpoint of plant-breeding, as the tomato. This is doubtless due to the fact that it is easily grown, commonly used, and offers exceptionally good opportunity for study.

The tomato plant is quickly susceptible to careful selection, and it is by this that value is given to cross results, whether natural or mechanical.

In selecting tomato seed it has been demonstrated that the plant as a whole has more hereditary influence than the character of the individual fruit.

Repeated experiments have shown that nothing is gained by selecting seeds from first ripe fruit, regardless of the character of the plant from which they come.

When new varieties are desired through crossing, the foregoing applies equally to each parent. The more uniform and persistent the parent, the greater is the chance that its characteristics will be transmitted.

When the desired variety is once realized, it is kept only by constant attention to selection. It is doubtless chiefly due to

Digitized by Google

carelessness in selection that our varieties of tomatoes as a whole are so comparatively short-lived.

Tillage, fertilization, and other treatment of plants have their effect upon tomato breeding. Poor soils and insufficient cultivation tend to revert the variety.

Keeping quality evidently has not been generally taken into consideration, up to the present time, in breeding the tomato. Experiments at the Cornell, New York, station go to show that solid varieties may not be the best keepers.

Hybridizing between the larger varieties and the clustered, or currant tomatoes, generally results in producing fruit intermediate in size.

Crosses between the large or potato-leafed and common-leafed varieties usually result in an intermediate foliage.

The red varieties seem to have the power to stamp their color on the offspring of crosses with other colors.

Varieties of tomatoes mix very readily when grown in the same field. Pure seed should be selected from isolated varieties.

The tomato, as with other crops, needs a rotation. The plants grown on the same land from year to year, although highly fertilized, naturally degenerate in time.

In order to secure results from crossing the tomato, one cannot be too well acquainted with the parent varieties, nor have too clearly defined plans of procedure. Haphazard crossing is of little value.

When the parents are very different in character, the chances are that the offspring will be weak, while the offspring of closely related species or races is likely to be very vigorous.

ORIGIN OF TOMATOES

The evolution of our cultivated tomatoes is interesting. The two species from which all our garden varieties have originated are *Lycopersicum pimpinellifolium* and *Lycopersicum esculentum*. The former includes the "Currant" varieties, which are small and borne in large clusters, sometimes spoken of as the "Raisin" tomatoes. This species is a South American variety, and is found growing wild in both Brazil and Peru. Although known for some time, comparatively little use has been made of them, except for pickles, preserves, and for ornamentation.

Digitized by Google

L. esculentum is the species from which our commercial tomatoes come. It is thought also to have originated in Peru, although it has been found in other countries, as in Mexico and California, in a form similar to the cherry tomato.

HISTORY OF GROWTH

While the tomato was known in Europe as far back as 1561, but four varieties were found in England in 1819. In these early days it was grown mainly for ornament. Prof. Munson finds that the fruit was first introduced into this country at Philadelphia by a French refugee from St. Domingo, in 1798; and again by an Italian painter, Comé, at Salem, Mass., about 1802. The beginning of general culture of the tomato for market is placed at about 1830. From this time up to the present, the evolution of the tomato has been steady. From the flat, rough, and angular tomatoes, beautiful, round, regular fruits have been developed. The Paragon variety was the first to be so developed. Since then other superior varieties have come and gone. One would think further improvement almost an impossibility, but doubtless the advancement of the next ten years will be as great, if not greater, than that of the last decade.

Digitized by Google

A
Sci 1636.35
HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1936

Bulletin 43 February, 1897

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

SOME INFERIOR WOOD ASHES

By Fred W. Morse

The time for purchasing fertilizers having come, the Station wishes to call the attention of farmers to the variable composition of wood ashes and particularly to some evidently fraudulent lots of Canada ashes, samples of which were received at the laboratory last fall.

Five samples, representing three different lots, were received during October, 1896, from widely different sections of the state, namely Plymouth, Stratham, and Walpole. The ashes were all bought of the same wholesale dealer, and analysis showed them to be quite uniform in quality; but noticeably inferior. By referring to the first five analyses in the table, it will be seen that the proportion of moisture is very high, amounting to 450 pounds of water in one ton of ashes as purchased.

The proportion of potash is low, especially if the soluble form is alone considered, which fact, taken with the quantity of water, leads one to suspect that these ashes had been either leached partially or prepared by mixing leached and dry ashes together. The proportion of lime found in the most inferior sample (467) disposes of any suspicion of adulteration with lime as the percentage is not high.

The price of these ashes was $10 per ton delivered in carload

Digitized by Google

lots at the respective railroad stations. This price is lower than any quotations previously known to the Station. The important point for purchasers, however, is that *the low price was accompanied by an apparently deliberate reduction in the quality of the ashes.*

During the year preceding the receipt of the five samples above described, the Canada ashes sent to the Station for analysis were of good quality, as will be seen by scanning the tabulated results. Number 309 is of interest because, though very moist, it yet contains a high percentage of potash. The ashes had most probably been exposed to rain, instead of having been leached and afterward partially dried. The same is also probably true of domestic ashes, No. 413.

Three samples of domestic ashes are characterized by being very dry, and No. 286 was probably taken soon after the ashes were removed from the stove. Average Canada ashes contain about 12 per cent. of moisture, which renders them as damp as the average chemical fertilizer. Buyers of ashes should therefore look with suspicion on lots that appear excessively moist, because in such cases the potash is seldom equal to the proportion in average ashes.

The refuse ashes were samples from burned rubbish, principally waste paper and refuse lumber. The analytical results speak for themselves. Ashes from paper are as valueless as those from coal, because the soluble mineral matter has been leached out of the paper stock during the process of paper making.

COMPOSITION OF ASHES.

Parts in 100.

CANADA ASHES, FALL, 1896.

No.	Locality.	Moisture.	Total phosphoric acid.	Soluble potash.	Total potash.	Lime.
460	Plymouth	24.80	1.13	2.62	3.24	
464	Walpole	23.90	1.04	2.48	3.15	
465	Walpole	21.00	1.09	3.22	3.62	
467	Stratham	25.25	.98	1.99	2.75	34.34
470	Plymouth	22.60	1.17	2.60	3.35	

Digitized by Google

CANADA ASHES, 1895-'96.

285	Plymouth	6.95	1.66	4.29	6.29	
287	Newington	14.40	1.24	4.13	5.50	
305	Epping	15.10	1.17	3.05	7.22	
306	Epping	15.80	1.20	3.00	5.75	
308	Hollis	11.23		7.04	8.20	
309	Plymouth	20.13		5.50	6.54	37.89
427	Lancaster	15.06	1.64	4.81	5.67	
428	Lancaster	12.30	1.60	4.84	5.46	
463	Intervale	13.95	1.50	4.40	5.13	

DOMESTIC ASHES.

286	Plymouth	.18	2.62	7.53	11.40	
413	Pittsfield	19.63	2.45	5.34	5.95	
414	Pittsfield	3.47	2.54	7.01	8.06	
459	Plymouth	2.59	2.68	6.02	7.39	

REFUSE ASHES.

351	East Pembroke	19.90	.81	.51	1.96	8.35
415	Pittsfield	20.50	.50	.34	2.05	

ADULTERATED PARIS GREEN.

Since the publication of Bulletin 36 on the composition of Paris green, a sample of that much-used insecticide has been received, which showed every evidence of premeditated fraud. The sample was sent from Alstead and was contained in a pasteboard box with unbroken seal. The package was labeled "Pure Paris Green," "The only sure Poison for Potato-Bugs, Etc.;" but bore no name of a manufacturer or agent.

The package was probably intended to pass for a half-pound, but weighed barely seven and one-half ounces before the seal was broken. The contents of the package were of a paler shade of green than those before analyzed, and contained small, white lumps, which were easily pulverized between the thumb and finger.

The material was found to contain only 30 per cent.

Digitized by Google

of arsenic trioxide, while 43.3 per cent. of the substance was insoluble in hydrochloric acid. Pure Paris green should be almost wholly soluble in acid and should contain from 55 to 60 per cent. of arsenic trioxide. Further examination of the sample showed it to contain 30.6 per cent. of silica and 5 per cent. of oxides of iron and aluminum. From these results it appears that this "Pure Paris Green" was a *mixture of about equal parts of Paris green and earthy matter*, either clay or infusorial earth.

Probably the best way by which users of this important insecticide may protect themselves, is to refuse to buy packages which bear no trade-marks of the manufacturers, since the samples reported in the previous bulletin as being pure were all plainly marked with their respective makers' names.

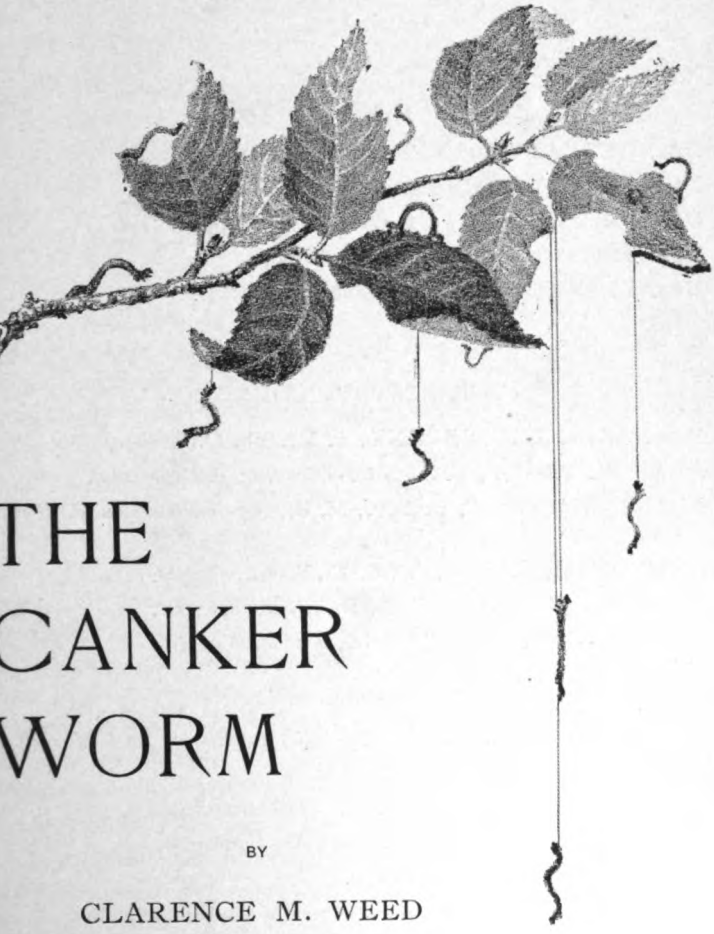
Digitized by Google

Sci 1636.35

Bulletin 44 April, 1897

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION



THE CANKER WORM

BY

CLARENCE M. WEED

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HON. FRANK JONES, Portsmouth.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS.

LEIGH HUNT, B. S., *Assistant Agriculturist and Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

THE CANKER-WORM

BY CLARENCE M. WEED

SEVERAL of the insect pests which afflict the New England farmer in this year of grace 1897 are the same as those which burdened his ancestors a century ago. This is especially true of the canker-worm; witness these paragraphs published in 1797, by Mr. Samuel Deane in *The New England Farmer or Georgical Dictionary:*

"The worm is produced from the eggs of an earth colored bug, which having continued under ground during winter, passes up on the bodies of apple trees early in the spring. They are hatched as early as the end of May, and are so voracious, that in a few weeks they destroy all of the leaves of a tree, prevent its bearing for that year, and the next, and give it the appearance of its having been burnt. As the perspiration of trees is stopped by the loss of their leaves, they sicken and die, in a few years.

"The worms let themselves down by threads in quest of prey, like spiders; by means of which, the wind blows them from tree to tree; so that in a close orchard, not one tree will escape them. But trees which stand singly are seldomer infested with these insects. As they are the most pernicious kind of insects with which New England is now infested, if any person could invent some easy, cheap, and effectual method of subduing them, he would merit the thanks of the publick, and more especially of every owner of an orchard."

Throughout the present century the canker-worm has remained one of the most destructive orchard pests. Its structure and life habits have caused the injury in each region to be

Digitized by Google

largely localized, an orchard here and there showing by the browning of the foliage the presence of the enemy, while neighboring orchards and isolated trees remain uninjured.

THE LIFE-HISTORY OF THE CANKER-WORM

In regions where the canker-worm is present in destructive numbers one will sometimes see orchards which in June appear seared and brown as if scorched by fire. Closer examination will show that the green portions of the upper surfaces of the leaves have been eaten off, so that there remain only the veins and more or less of the withered under surface. Had you observed the trees during May you would have found myriads of looping caterpillars each busily feeding upon the succulent tissues. These canker-worms are green or brown, more or less striped with longitudinal lines. Just back of the head are six legs with pointed claws, and near the posterior end of the body are four or six other legs, different in form. When the caterpillar crawls the middle of the body assumes the shape of a hump or loop; on account of this these insects are called looping caterpillars or measuring worms. If the twig upon which they are stationed is jarred, each caterpillar drops earthward, spinning from its mouth a silken thread, which prevents too sudden a descent to the earth below.

Early in summer, the canker-worms become full-grown in the larval state. They then enter the soil two or three inches, sometimes simply seeking the shelter of the rubbish upon its surface, where, protected by silken cocoons in cells, they change to pupæ. There they remain until autumn or the following spring, when the moths emerge. In these, the sexes are strangely different; the males are small of body and large of wing, well adapted to easy flight; while the females are large of body, and wholly destitute of wings. The latter are thus doomed to pass the short remainder of their lives in the vicinity of their emergence. They crawl up the trunks of neighboring trees, where upon the twigs they deposit their eggs, dying soon afterwards. When the leaves appear, bursting through the buds, the eggs hatch into the young caterpillars, that feed upon the tender foliage.

Digitized by Google

There are two distinct species of canker-worms, the fall canker-worm (*Anisopteryx pometaria*) and the spring canker-worm (*Paleacrita vernata*). The moths of the former emerge mostly in autumn, while those of the latter appear in spring. The various stages of the spring species are represented in Fig. 2, and of the fall species in Fig. 3. As will be seen, the insects resemble each other, one of the chief differences being in the shape of the egg (see *b* in each figure). Both species are found in New Hampshire.

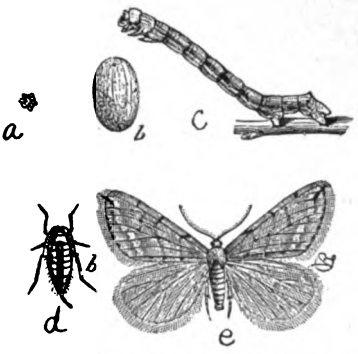


FIG. 2.—The spring canker-worm: *a*, egg mass, natural size; *b*, egg, magnified; *c*, larva; *d*, female moth; *e*, male moth. (After Riley.)

The canker-worm is distributed largely through the action of the wind in blowing suspended larvæ from one tree to the vicinity of another. Lowell has described the process in these lines:

> "The worm, by trustful instinct led,
> Draws from its womb a slender thread
> And drops, confiding that the breeze
> Will waft it to unpastured trees."

THE ENEMIES OF THE CANKER-WORM

Fortunately, the canker-worm is beset by enemies from the time the egg is laid until the adult moth dies. There is a tiny parasite which develops in the egg, destroying its contents. There are several species of parasites which prey upon the larvæ, as well as various predaceous insects which devour it bodily. But perhaps the most effective enemies are the birds; repeated observations and investigations have shown that nearly all our common birds feed freely on the canker-worm. Apparently, no other injurious insect is taken so freely by a great variety of birds. The observations made in Massachusetts, by Mr. C. E. Bailey, and reported by Mr. E. H.

Digitized by Google

Forbush[1] show that the chickadee, or black-capped titmouse, devours the eggs throughout the winter, and the moths when they are present. "Mr. Bailey is very positive that each chickadee will devour on the average thirty female canker-worm moths per day from the twentieth of March until the fifteenth of April, provided these insects are plentiful. If the average number of eggs laid by each female is 185, one chickadee would thus destroy in one day, 5,550 eggs; and in the twenty-five days in which the canker-worm moths crawl up the trees, 138,750. It may be thought that this computation is excessive, and it is probable that some of the moths were not captured until they had laid some of their eggs, but the

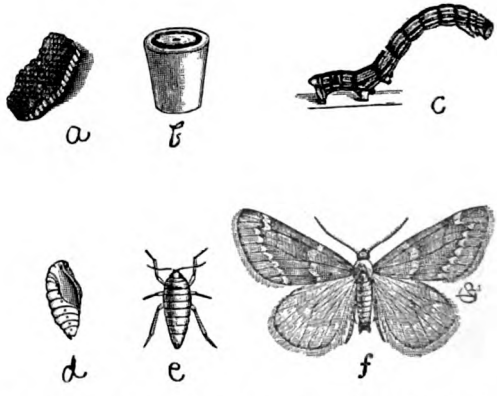


FIG. 3.—The fall canker-worm; *a*, egg mass, natural size; *b*, egg, magnified; *c*, larva; *d*, pupa; *e*, female moth; *f*, male moth. (After Riley.)

chickadees are also busy eating these eggs. When we consider further that forty-one of these insects, distended as they were with eggs, were found at one time in the stomach of one chickadee, and that the digestion of the bird is so rapid that its stomach was probably filled several times daily, the estimate made by Mr. Bailey seems a very conservative one. He now regards the chickadee as the best friend the farmer has, for the reason that it is with him all the year, and there is no bird that compares with it in destroying the female moths

[1] Mass. Crop Report, July, 1895.

Digitized by Google

and their eggs." Similar evidence concerning the value of various other birds as canker-worm destroyers could be readily adduced, did space permit. There is no question that the encouragement of the presence of birds is a quality of mercy that is twice blessed, for it blesseth him that gives and those that receive.

PREVENTING THE INJURY

The injuries of the canker-worm may be prevented in two ways: If the trunk of the tree be smeared with some preparation which will prevent the female moths or the worms from ascending it, no injury can result. This device is frequently employed, heavy wrapping paper smeared with printer's ink or some similar viscid substance being fastened around the trunk of the tree (Fig. 4). There are now upon the market two preparations called *raupenleim* and *dendrolene* which are used in place of printer's ink and serve the purpose very well. They remain sticky for a long time. Various mechanical appliances, in the shape of tin troughs and bands, are also used to accomplish the same object.

FIG. 4.—Trunk of tree, showing paper band. (Original.)

This banding method is particularly serviceable in protecting large elm trees, which are difficult to spray on account of their height. The loose bark should be carefully scraped off the portion of the trunk which is to be covered by the paper, before the latter is put on; and it is generally worth while to insert a thin layer of cotton waste, or some similar material, beneath the paper to fill up crevices, and thus prevent any moths or worms from crawling through beneath the paper. Then the dendrolene or raupenleim may be smeared upon the paper to the thickness of about one-fourth of an inch, and left as long as it remains sufficiently sticky to entrap any insect that

Digitized by Google

attempts to pass over it. Either of these substances will remain for two or three months in a sticky condition. To prevent canker-worm injury, an application early in March, and another the first of September will probably suffice. It has sometimes been recommended to smear raupenleim and dendrolene directly upon the bark of the tree, but recent experience has shown that there is danger of thus injuring the tree through the absorption of the materials of which the application is composed. It is probably worth while to take a little

FIG. 5.—A New York spraying outfit. (After Bailey.)

more trouble and use the paper, rather than run any risk of loss. The dendrolene may be purchased of the Bowker Fertilizer Company, of Boston, and the raupenleim of William Menzel & Son, 64 Broad St., New York, N. Y.

If thoroughly applied, the bands being kept on throughout the entire season, during which the moths and caterpillars appear—from September till June—this banding method is easily applicable to orchard practice. In cases where the attack the previous season was severe, it will generally pay to apply the bands, even if the orchardist expects to spray his

Digitized by Google

trees, for it has been the general experience that an orchard badly infested by canker-worms cannot be wholly freed from the pests the first season, before considerable damage is done to the foliage. Some New Hampshire farmers have told me they preferred to fight the canker-worm by the banding, rather than the spraying, method, because their other work kept them so busy during the spraying season. But, in general, the orchardist will find it profitable to spray, because he can thus kill off not only the canker-worms and other leaf-eating insects, but the codling-moth as well, and if he so desires, he can in the same mixture fight the apple scab and other fungous diseases.

When an orchard is infested by canker-worms it is very desirable to spray once before the blossoms open. The insects begin hatching early in the season; if trees are not sprayed until after the blossoms fall, considerable damage will be done before the worms are killed. One spraying when the buds are in the condition represented in Fig. 6 will be of much service. Another should be given as soon as the blossoms fall; and if the canker-worms are very numerous a third—a week or ten days after the second—will be desirable.

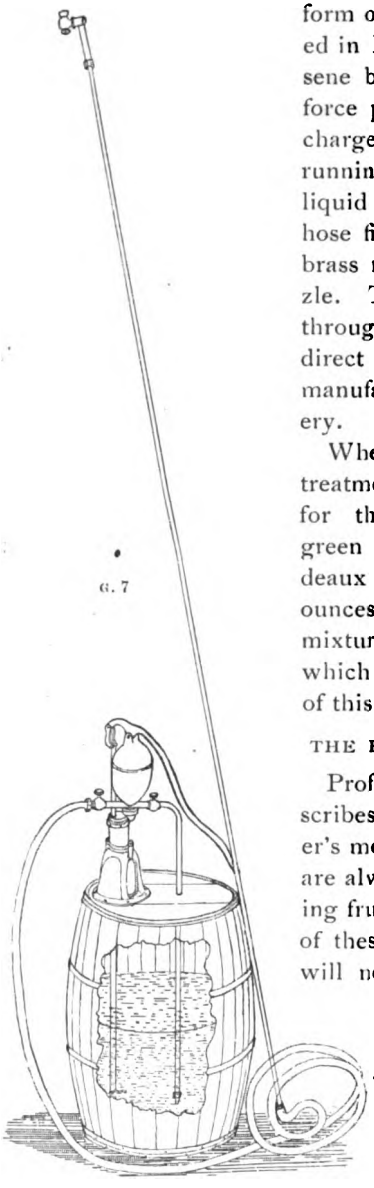
FIG. 6.—Time to spray. (After Bailey.)

For insects alone the best mixture to use in apple-orchards is probably Paris green, one pound to two hundred gallons of water with two pounds of fresh-slacked lime added to render all the arsenic insoluble and thus prevent injury to foliage.

Repeated experience has demonstrated that spraying must be thoroughly done to be effective. The leaves throughout the tree must be wet with the spray. In this work haste is waste; a stitch in time will save many times nine.

The ease with which spraying is carried on depends to a considerable extent upon the facilities provided. The outfit shown in Fig. 5 is used by a New York fruit grower. Many other forms of outfits have been made and successfully employed. It is, of course, a distinct advantage to apply the spray from some distance from the ground. For small orchards a simple

Digitized by Google



G. 7

form of spraying outfit is represented in Fig. 7. It consists of a kerosene barrel holding fifty gallons, a force pump having a double discharge, with a short line of hose running into the barrel to keep the liquid stirred, and a long line of hose fitted at the end to a slender brass rod tipped with a spray nozzle. This outfit can be obtained through any hardware dealer, or direct from any of the numerous manufacturers of spraying machinery.

Where it is desired to combine the treatment for apple scab with that for the canker-worm, the Paris green may be added to the Bordeaux mixture at the rate of four ounces of poison to fifty gallons of the mixture, full directions for making which will be found in Bulletin 45 of this Station.

THE FRUIT GROWER'S INSURANCE

Professor L. H. Bailey wisely describes spraying as the fruit grower's method of insurance. "There are always elements of risk in growing fruit," he writes. "The chief of these is frost, a difficulty which will never be completely under our control. The second great element of risk is the injury wrought by insects and fungi, and the greater part of this injury can be averted by the sprays. Now, it is

Digitized by Google

impossible to foretell by any considerable length of time, if any or all of the difficulties which are liable to harass the fruit raiser will actually appear. One does not know if his buildings will burn, yet he insures them. We know that in four years out of five, some serious injury of insects or fungi may be confidently expected, and it is the part of wisdom to insure against it.

"Last year, 1894, was a season of remarkable invasion of apple-scab fungus, and those persons who sprayed their orchards thoroughly had phenomenal results. These experiences, aided by many publications upon the subject, so advertised the value of the sprays that much more spraying was done in the state this year than ever before. But it has so happened, probably because of the dry spring, that comparatively few invasions of enemies have occurred this year; and the sprays have generally given small results. There has now arisen, therefore, considerable indifference or even opposition to spraying, and I expect to see much less of it next spring than I saw this spring. If, then, next year should be prolific in insects and diseases, there will be a few orchards here and there which will reward the forethought of the owner, and very many others which will be monuments of the results of neglect. It is a common fault with farmers that they draw their conclusions from the behavior or experiences of each recurring season, and do not consider the aggregate results of a series of years. Every operation should rest upon some fundamental reason or philosophy, rather than upon any single half-understood experience."

The year 1896 was remarkable for a phenomenal apple crop and consequent low prices. Presumably, 1897 will see a small apple crop and high prices. The small crop will be liable to much greater injury from insect enemies than a larger one would be. Consequently, it seems fair to conclude that where trees blossom and set fruit freely it will pay to take a little trouble to get it matured in good condition.

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 45 May, 1897

HARVARD COLLEGE LIBRARY

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

FRUIT AND POTATO DISEASES

SPOT DISEASE OF APPLE

BY H. H. LAMSON

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HON. FRANK JONES, Portsmouth.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS.

LEIGH HUNT, B. S., *Assistant Agriculturist and Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

Experiments in the Treatment of Fungous Diseases of Fruit and Potatoes

BY H. H. LAMSON

The diseases with which this Bulletin is concerned are those known as fungous diseases. They are not due to insects, which belong to the animal kingdom, but to members of the vegetable kingdom—that is to say, plants. These disease-producing plants belong to the class known as fungi, and as they grow upon other plants, they are called parasitic fungi. They are so small that their nature cannot be made out by the naked eye, so that it is not strange that they are not so well understood by the majority of people as are insects. The parasitic fungi grow at the expense of the plant on which they live, and cause, in many cases, serious damage; and in the case of cultivated plants, great pecuniary loss. It has been found that many of these diseases may be largely prevented by spraying with some substance which is harmless to the cultivated, but poisonous to the fungous, plant.

DISEASES OF THE APPLE AND PEAR

The most serious fungous disease of the apple and pear is usually the *scab*. This disease appears on both the fruit and the foliage. On the fruit it appears as dark green or almost black spots, with a velvety surface. The spots are circular in outline, and occur separately or run together in irregular patches, often covering a large portion of the surface. The spots are thickened, and slightly raised above the surface, so that the term *scab* is very applicable to the disease.

A fruit which is badly affected with the scab is usually deformed or one-sided, and frequently cracked so as to be worthless. Certain varieties of both apples and pears are more

Digitized by Google

liable to be attacked by this disease than others. Upon the foliage the scab appears as black or dusky irregular patches upon the upper surface of the leaf. The scab is caused by a parasitic fungous plant, which finds its proper soil on the fruit or leaf. The disease is spread by spores which develop on the surface of the scab spots.

The amount of damage done by the scab varies from year to year. In some years it is very prevalent, while in others it does comparatively little injury.

The scab is one of the diseases which can be most effectually prevented by spraying with a fungicide such as the Bordeaux mixture.

During the last three years the Baldwin apple, which is very largely grown in southern New Hampshire, has been badly affected by another fungous disease entirely different from the scab. This disease is characterized by the appearance on the surface of the apple of numerous small brown spots, varying in diameter from a sixteenth to an eighth of an inch (see cover). The spots are slightly sunken or depressed, so that the surface has a pitted appearance. They suggest the beginning of rot, but they do not seem to increase in size ordinarily, though occasionally they do. They do not affect the tissues of the apple deeply, and the principal damage done by the disease seems to be the disfigurement of the fruit, which is often great, rendering an otherwise perfect apple a second.

The following experiments show the effect on this disease of spraying with Bordeaux mixture.

Experiment I.—Season of 1895, on Baldwin apples:

A plot of trees A was sprayed four times with 1 to 10 Bordeaux mixture (1 to 8, 1 to 10, 1 to 12 Bordeaux mixture mean that 1 pound of blue vitriol was used for every 8, 10, or 12 gallons of water), twice before blossoming, May 4 and 10, and twice after blossoming, May 28 and June 14.

A plot of trees B was sprayed with 1 to 10 mixture once before, May 10, and twice after blossoming, May 28 and June 14.

A plot of trees C was sprayed with 1 to 8 mixture three times, May 10, 28, and June 14.

A plot of trees D was sprayed with 1 to 12 mixture three times, May 11, 29, and June 15.

Digitized by Google

At the first spraying after the blossoms had fallen, May 28, 4 ounces of Paris green were added to each 50 gallons of Bordeaux mixture for the codling-moth. This experiment is therefore a good illustration of a combined treatment for fungi and insects.

The apples, when gathered, showed the following results:

Apples from unsprayed check trees, as well as from the sprayed trees, were examined one by one and counted. The first table compares the total number of apples unsprayed and sprayed.

	Unsprayed.	Sprayed.
Free from spots and worms	19 per cent.	82 per cent.
Spotted	55 "	3 "
Wormy	58 "	15 "

Of the unsprayed, 9⅓ per cent. were graded as No. 1's.

Of the sprayed, 53 per cent. were graded as No. 1's.

The following table compares the effects of the different modes of treatment of the sprayed trees on the spot disease:

	Plot A.	Plot B.	Plot C.	Plot D.
Free from spots .	95 per cent.	99 per cent.	96 per cent.	99 per cent.

These results show the efficiency of the Bordeaux mixture in preventing the disease, with but little difference between the different strengths and times of applying it.

Experiment II.—Season of 1896, on Baldwin apples:

Plot 1. Trees sprayed twice with 1 to 10 Bordeaux mixture, once before blossoming and once after.

Plot 2. Trees sprayed with 1 to 10 Bordeaux mixture once after blossoming.

Check trees unsprayed.

Result:	Unsprayed.	Sprayed.	
		Plot 1.	Plot 2.
Free from spots . . .	32 per cent.	90 per cent.	82 per cent.
Spotted	68 "	10 "	18 "

This shows a slight gain in favor of the trees sprayed twice.

In 1896 another disease was very prevalent on apples, and together with the spot disease rendered much of the crop very

Digitized by Google

unsightly. This disease is characterized by dirty or sooty spots on the skin of the apple. The spots are roundish in outline; varying much in size, they often run together, covering nearly or quite the whole surface of the fruit. If drops of water containing soot or lampblack were allowed to evaporate on the surface of the apple, they would produce an appearance resembling this disease. Its fungous nature, however, is clearly revealed by the microscope. It is entirely superficial and, as in case of the spot disease, the principal damage produced by it is disfigurement. This disease is frequently observed on Greenings and Northern Spies, but in 1896 it attacked many other varieties, among them the Baldwin.

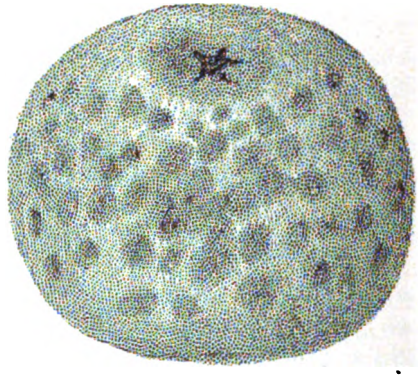


FIG. 2.—Apple affected with sooty disease.

The sooty disease frequently attacks pears; it is especially bad on Beurre de Anjou and Lawrence. In case of the latter, the favorable effect of spraying with Bordeaux mixture has been reported on in a previous Bulletin of this station (No. 27).

In 1896, although no exact count was made, it is safe to say that the sprayed apples showed 75 per cent. less of the disease than the unsprayed.

BLACK KNOT OF PLUM

It is probable that plums might be raised with profit in many parts of New Hampshire, if it were not for the disease known as *black knot*. Until recently it has been thought that the only

Digitized by Google

efficient remedy for it was to cut off and burn the knots, but from experiments at several stations, it seems probable that the disease may be controlled by spraying with a fungicide. In order that the spraying may be effective, it is necessary to know something of its life history. Black knot is caused by a fungous plant which grows in the inner bark of the tree, causing it to swell and crack open. The fungous plant reproduces itself by means of spores, of which there are two principal kinds. One kind is known as the summer spore, and the other as the winter spore.

The summer spores are formed soon after the bark cracks open in the spring, in May or June, and serve to spread the disease at that time. After this form of spore has disappeared, a change takes place in the young knot, in which it assumes its well-known appearance of a black swelling on the twigs or branches. The surface of the black swelling is now thickly studded with minute pimple-like projections, in the interior of which are produced the winter spores. This form of spore is mature and capable of germination in February or March and serves to spread the disease early in the spring, when the leaves and young shoots are making their appearance.

The spraying against this disease should be done at such a time as will bring the fungicide in contact with the spores before they have time to germinate and infect the trees. Hence it is recommended that the trees be sprayed early, before growth begins, and again when the buds are ready to burst. These sprayings are to destroy the winter spores. To destroy the summer spores, the trees should be sprayed about the last of May, and again about the middle of June. The best fungicide for this purpose is the Bordeaux mixture. If this treatment is faithfully followed, it is probable that the disease will, to a large extent, be prevented. If spraying is not done, the trees should be carefully examined in the spring and fall, when the leaves are off, for knots or swellings; these, when found, should be removed and burned. Where large wounds are made by this pruning, they should be covered with paint of some kind.

It would be well if there were a law in New Hampshire, properly enforced, compelling each fruit grower to keep his

Digitized by Google

trees free from the black knot. The wild cherries are affected with the same disease, and must be attended to if the disease is to be stamped out.

DISEASES OF THE POTATO

The potato is subject to three serious diseases, viz., the *early blight*, the *late blight*, and the *scab*, all caused by parasitic plants or fungi. As their names indicate, the two blights, or rusts, as they are frequently called, differ in their time of appearance. The early blight may appear in June upon early potatoes. Upon late potatoes it does not appear usually before the middle or last of July. The late blight appears about the first of August. Besides this difference in time of attack, the two diseases possess distinct characteristics, which may be readily made out by any one on a careful examination of the affected vines. The early blight produces dark brown, sharply defined spots upon the leaves, which increase in number and size until the whole leaf may be destroyed. This disease does not attack the tubers. The late blight is characterized by the rapid withering and death of the leaves, without the appearance of sharply defined spots. It usually begins at the margins, and soon involves the whole leaf. Upon the under side of the leaves, along the line separating the dead from the living portion, may be observed a whitish, mold-like growth, which the microscope shows to consist of the spore stalks of the fungus plant which is causing the trouble. This white mold, the absence of well-defined spots, and the rapid dying of the leaves, serve to distinguish the late blight from the early. We frequently find vines affected with both diseases at the same time. The blights can be successfully treated by spraying.

The following are results obtained in treating potatoes for early blight:

	Bushels per acre.	Gain from spraying.
Sprayed four times with 1 to 10 Bordeaux mixture	237	
Unsprayed adjacent plot	185	52 bushels.
Sprayed twice with 1 to 10 Bordeaux	352	
Unsprayed adjacent plot	287	65 "
Sprayed three times with 1 to 10 Bordeaux	337	
Unsprayed adjacent plot	255	82 "
Sprayed three times with 1 to 10 Bordeaux	320	
Unsprayed adjacent plot	246	74 "

Digitized by Google

These results fairly represent the value of spraying, but as the depredations of the fungous diseases vary so much from year to year, and with other varying conditions, more favorable as well as less favorable ones may be obtained.

The *scab* of potatoes is caused by an organism which, while of a vegetable nature, differs considerably from those causing the blights. The scab of the potato has no similarity or relation to the above-described scab of the apple. The appearance of scabby potatoes needs no description. The organisms causing the disease may be present in the soil or upon the seed used. It has been found that certain forms of fertilizers, while they do not cause the disease, produce a condition of the soil which is especially favorable for its development. These fertilizers are stable manure, ashes, and lime or plaster.

Treatment of the scab. If possible, seed free from scab should be planted, but under ordinary conditions it is difficult to be certain that the seed is wholly uncontaminated. Potatoes should not be planted a second time on soil which has previously produced a scabby crop. The use of the above-mentioned fertilizers should be avoided. Seed may be freed from all or most of the germs by soaking in a solution of corrosive sublimate. This treatment may be carried out in the following way: Dissolve corrosive sublimate in water at the rate of one ounce to eight gallons of water. Keep this solution in a wooden vessel; a barrel, half barrel, or wash-tub will answer the purpose. Put the potatoes to be treated in a coarse sacking bag, and plunge in the solution; let them remain for an hour and a half, moving them about occasionally to insure thorough wetting; then dry the potatoes, and they are ready for planting. Care should be taken that they do not become contaminated again by dirt from untreated potatoes. It should be remembered that corrosive sublimate is a violent poison if taken internally, therefore care should be taken in using it.

In 1895 the following experiment was made, to ascertain the effect of different fertilizers on the development of the scab: Four plots of 4 rows each were planted.

Plot 1 was fertilized with commercial fertilizer.
Plot 2 was fertilized with stable manure.
Plot 3 was fertilized with plaster.
Plot 4 was fertilized with wood ashes.

Digitized by Google

The seed used was very scabby. Two rows of each plot were planted with the seed untreated; the other two rows, with seed soaked in solution of corrosive sublimate, as above described.

When dug, the potatoes showed the following result: The figures indicate the per cent. of scabby ones.

	Commercial fertilizer.	Stable manure.	Plaster.	Ashes.
Treated .	8 per cent.	3 per cent.	12 per cent.	10 per cent.
Untreated ..	37 "	14 "	56 "	41 "

These results show the beneficial effect of treating the seed, but do not fully bear out the statement made above in regard to the effect of the different fertilizers.

BORDEAUX MIXTURE

The Bordeaux mixture continues to recommend itself as the best all-round remedy for fungous diseases. It is efficient, it is cheap, and it is easily prepared when one once gets the "hang" of it and is willing to take pains. Directions should be carefully followed by those who are unfamiliar with its preparation.

The ingredients of the Bordeaux mixture are blue vitriol, lime, and water. The ingredient which kills the fungus is the blue vitriol. The purpose of the lime is to prevent the injury to the foliage which a simple solution of blue vitriol would cause.

The proportion of the ingredients may be varied considerably. The formula which was recommended in Bulletin 27 of this Station still seems to us a satisfactory one, namely:

Blue vitriol	1 lb.
Lime, fresh	⅔ "
Water	10 gals.

As the quantity most frequently prepared would be a barrel, the formula may be given as follows:

Blue vitriol . . .	5 lbs.
Lime	3⅓ lbs.
Water	1 bbl. (45 to 50 gals.)

Digitized by Google

For convenience in weighing, 3½ lbs. of lime may be used. This makes what we have designated as a 1 to 10 mixture. The one described below by Mr. Galloway is a 1 to 8¼ mixture. It will not do to throw these ingredients together haphazard and expect a good result. The blue vitriol should be dissolved separately; this can be done with cold water, but it requires considerable time and is best done in the way described by Mr. Galloway. When wanted for immediate use, it may be dissolved rapidly in hot water, two quarts of which will dissolve a pound. A good way is to prepare a stock solution in quantity beforehand, making it of such strength that a half gallon or a gallon will contain one pound.

Only fresh lime should be used. Select the firm, uncrumbled lumps. Slack it by adding water slowly, just enough to keep it from burning or becoming dry until the lumps are all broken up, then add water enough to make a thin paste. The method of mixing the solution of blue vitriol and the lime recommended by Galloway is the ideal one, and even when it is not convenient to follow it in detail, the principle involved should be followed; that is, to dilute both the blue vitriol and the lime as much as possible before mixing.

If the quantity of *fresh* lime given in the formula be used, it will not be necessary to test the mixture. But it is often convenient to make up a considerable quantity of lime paste, and inconvenient to measure it afterwards; then a test which will tell when enough lime has been used will be convenient.

Dissolve a lump of yellow prussiate of potash (which may be obtained at any drug store) as large as a chestnut in a gill of water, and keep in a bottle; add a few drops of this to a saucerful of the prepared mixture. If a brown color appears, add more lime to the mixture, and test again. When sufficient lime has been used, no brown color will appear on applying the prussiate solution. Other tests are given below.

The following explicit directions for making the Bordeaux mixture were written by Mr. B. T. Galloway, of the United States Department of Agriculture: In a barrel or other suitable vessel place twenty-five gallons of water. Weigh out six pounds of copper sulphate, then tie the same in a piece of coarse gunny sack, and suspend it just beneath the surface of the

Digitized by Google

water. By tying the bag to a stick laid across the top of the barrel, no further attention will be required. In another vessel slack four pounds of lime, using care in order to obtain a smooth paste, free from grit and small lumps. To accomplish this, it is best to place the lime in an ordinary water pail and add only a small quantity of water at first, say a quart or a quart and a half. When the lime begins to crack and crumble and the water to disappear, add another quart or more, exercising care that the lime at no time gets too dry. Toward the last, considerable water will be required, but if added carefully and slowly, a perfectly smooth paste will be obtained, provided, of course, the lime is of good quality. When the lime is slacked, add sufficient water to the paste to bring the whole up to twenty-five gallons. When the copper sulphate is entirely

FIG. 3.—Making Bordeaux mixture. Pouring together the lime milk and copper sulphate solution.

dissolved and the lime is cool, pour the lime milk and copper sulphate solution slowly together into a barrel holding fifty gallons, as shown in Fig. 3. The milk of lime should be thoroughly stirred before pouring. The method described ensures good mixing, but to complete this work the barrel of liquid should receive a final stirring, for at least three minutes, with a broad wooden paddle.

"It is now necessary to determine whether the mixture is perfect—that is, if it will be safe to apply it to tender foliage. To accomplish this, two simple tests may be used. First insert the blade of a penknife in the mixture, allowing it to

Digitized by Google

remain there for at least one minute. If metallic copper forms on the blade, or, in other words, if the polished surface of the steel assumes the color of copper plate, the mixture is unsafe and more lime must be added. If, on the other hand, the blade of the knife remains unchanged, it is safe to conclude that the mixture is as perfect as it can be made. As an additional test, however, some of the mixture may be poured into an old plate or saucer, and while held between the eyes and the light, the breath should be gently blown upon the liquid for at least half a minute. If the mixture is properly made, a thin pellicle, looking like oil on water, will begin to form on the surface of the liquid. If no pellicle forms, more milk of lime should be added."

FIG. 4.—Testing the Bordeaux mixture by the plate method.

The Bordeaux mixture should be applied with a pump designed especially for spraying. Such pumps may be obtained of almost any hardware dealer. In spraying, it is necessary to keep the mixture thoroughly stirred. Only freshly made mixture should be used.

Bordeaux Mixture in a Dry Form.—This, in the form known as "Fungroid," has not proved satisfactory with us. The potato vines, to which it was applied, showed little, if any, benefit from its use. It is doubtful if any fungicide in a powdered form will be as efficient as a liquid one.

HOW TO SPRAY

In Bulletin 101 of the Cornell Experiment Station, Prof. L. H. Bailey, among many other things worth quoting, says, in

Digitized by Google

regard to spraying : " Spray thoroughly or not at all. I should say that fully half the spraying which I have seen in western New York in the last two or three years is a waste of time and material. Squirting a few quarts of water at a tree as you hurry past it, is not spraying A tree is thoroughly and honestly sprayed when it is *wet all over*, on all the branches and on both sides of all the leaves. An insect or fungus is not killed until the poison is placed where the pest is." Again he says: " The farmer should know what he wants to kill, before he begins to spray. It is common to find a man who is going at spraying with enthusiasm, but who cannot explain a single definite object which he has in view. He simply knows upon general principles that spraying is useful. To such a man, spraying is spraying, whether he uses Paris green or Bordeaux, or both, or neither one; and his results are about equal to his knowledge. There is no longer excuse for such ignorance, for all the leading insects and fungi have received more or less exact treatment in the publications of the experiment stations."

WHEN TO SPRAY WITH BORDEAUX MIXTURE

For Scab and Other Fungous Diseases of the Apple and Pear.—Spray once before the blossoms open, and again as soon as the blossoms fall, and a third time two weeks later.

For Black Knot on Plum.—Spray once before the buds begin to swell, and again just before they burst. These sprayings are directed against the winter spores. For the summer spores, spray the last of May and again about the middle of June.

For Early Blight on Early Potatoes.—Spray when the vines are about two thirds grown, and a second time two weeks later.

For Both Early and Late Blight on Late Potatoes.—Spray three times: the middle of July, the first of August, and the middle of August.

Rainy weather may render it advisable to spray at shorter intervals, and to increase the number of sprayings.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 46 **August, 1897**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

1. AN EXPERIMENT WITH A STEAM DRILL
2. METHODS OF ROAD MAINTENANCE

BY CHARLES H. PETTEE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HON. FRANK JONES, Portsmouth.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
CLEMENT S. MORRIS, *Clerk.*
E. H. FORRISTALL, *Farm Foreman.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

AN EXPERIMENT WITH A STEAM DRILL

BY CHARLES H. PETTEE

OBJECT OF EXPERIMENT

The experiment herewith described has been carried out with certain definite ends in view, and incidentally the location has been so chosen as to partially carry out a far-reaching improvement that is at present beyond the means of the town, and yet is absolutely essential to properly set off the approaches to the college. The definite ends were as follows:

1st. To use a steam drill on a sufficiently large scale to determine how far its well-known advantages may be applicable to country road work.

2d. To study the question of comparative cost of moving road material, differing in kind and having a variable length of haul.

3d. To incidentally make a further study of the question of what a standard grade should be.

4th. To experiment with different available materials for surfacing.

DESCRIPTION OF LOCATION AND OF WORK DONE

The locality selected for experiment lies upon the main thoroughfare through the village of Durham, with the property of the New Hampshire College upon either side. This thoroughfare, for over a mile, is bordered upon one or both sides for nearly the whole distance by land of this institution. The street itself as laid out is 66 feet in width, and is nearly straight, but the traveled portion varies considerably from a straight line. Here and there masses of rock encroach upon this traveled way and force it to one side. In other places, deep

Digitized by Google

ravines, requiring heavy fills, have been equally potent in pushing the roadway from the centre, and both together have caused the sidewalk to curve out toward the centre of the road until that thoroughfare has been encroached upon seriously in places.

Commanding the approach to the main college buildings from the village side, was a hill 510 feet in length, having a continuous grade the whole distance, except for 50 feet near the top, which was level. While the grade was continuous, it varied from one in eight for a distance of 55 feet to one in thirty for a distance of 120 feet, and these grades were so situated as to give a sharp rise for 90 feet in length near the bottom; then an easy grade for 175 feet; then a very steep ascent for 55 feet, with an easy slope beyond. These grades may be seen as represented by the broken lines in plate 1, figure 1, in which the vertical scale is exaggerated five times over the horizontal. The whole line in the same figure shows the grade of the road since its improvement. The lower part of the hill has been reduced to a uniform grade of one in twenty, while the upper portion has a grade of one in twenty-two. In plate 1, figure 2, the straight or nearly straight dotted lines show the former course of the traveled way and sidewalk; the broken lines show the present position of sidewalk, and the whole lines give the bounds of the street as laid out and the bounds of the traveled way as now built. The dotted curved lines indicate the former position of rock areas now removed by blasting. The frontispiece and plates 2–6 give views taken before, during, and since the reconstruction of the road. The traveled way has been graded 22 feet in width, with dirt slopes of one to one at the sides. The sidewalk upon the north side has been rebuilt in its proper place upon the outer edge of the laid-out way, for which purpose a large amount of rock excavation and fill were necessary. Ultimately, as the land on the south is improved, the grade of the road should be carried to the full width of 66 feet. In the part experimented upon, which includes about three fourths of the grading required for its full renovation, care has been taken to do no work which will have to be undone, but the remainder may be carried forward at any time with no interruption to travel. Enough has been done to

Digitized by Google

PLATE I.

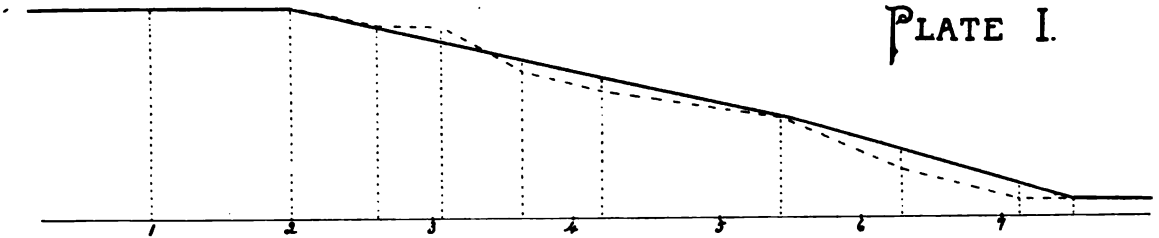


Fig. 1.
(ELEVATION.)

HORIZONTAL SCALE, 100'-1". VERTICAL SCALE, 20'-1".

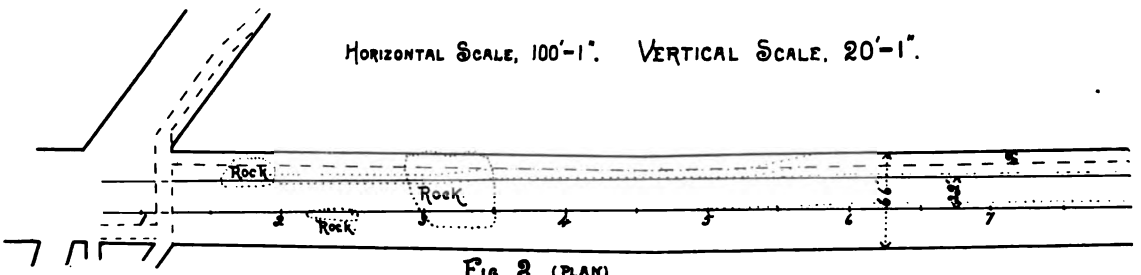


Fig. 2. (PLAN)

Digitized by Google

prepare this portion of the road for macadamizing, an improvement which it is hoped the town may be able to undertake at no distant day.

RESULTS IN DETAIL

The following table gives in detail the actual results accomplished, together with the cost of each part of the work. The expenses include what were actually incurred and what would have been incurred if the town had been doing the work without aid from the college.

GRADING.

No. cubic yds.	Material.	Aver'ge length of haul.	Source.	Basis of estimate.	Average cost per cubic yard hauling.	Total cost.
554	Clay.	⅜ mile.	College barn.	Count of loads.	27½ cts.	$152.35
146	Hard pan.	5-16 mile.	Rear of Science buildi'g.	Count of loads,	27½ cts.	40.15
24	Hard pan.	½ mile.	Holtt bank.	Count of loads.	27½ cts.	6.60
50	Hard pan.	200 feet.	Stripping.	Measurements.	27½ cts.	13.75
22	Hard pan.	100 feet.	Ditch.	Measurements.	15 cts.	3.30
15	Cinders.	5-16 mile.	Power station.	Count of loads.	22½ cts.	3.32
16	Gravel.	2½ miles.	Lee gravel bank.	Count of loads.	65½ cts.	10.50
130	Stone.	250 feet.	Stone wall.	Measurement in embankment.	45½ cts.	59.18
258	Stone.	125 feet.	Blasted from ledge.	Measurement in ledge.	111 cts.	286.38

Spreading earth and shaping road-bed	$28.84
Supervision, 36 days at $2.00	72.00
520 loads of earth at 10 cents	52.00
Two culverts—64 feet of pipe, $9.60; labor, $7.72	17.32
Total value of work done	$744.80
Acutal outlay to college	$500.00

If of total cost we rebate amounts for supervision, value of earth furnished, amounts charged for use of drill and machinery, and excess of value of farm teams above $3.00 per day (college experiments are usually carried on upon a basis of expense of $3.00 per day per team, while in table this has been charged

Digitized by Google

at $3.50 per day), and if we allow something for the value of the stone reserved by the college, the actual net outlay will remain nearly $500, as given above.

Of the total fill, one third was for sidewalk, two thirds for roadway. Of the rock excavation, two thirds was for sidewalk, and one third for roadway. On the whole, 56 per cent. of cost was for roadway, and 44 per cent. for sidewalk.

The cost of moving clay, hard pan, and strippings varied from 25 to 40 cents per yard, differing mainly with the kind of labor employed in shoveling.

RÉSUMÉ

827 yards earth, estimated to shrink in place 1-10 to	744 yards.
258 yards stone, less 20 yards drawn to college barn, equals 238 yards, estimated to increase in place 1-6, to	275 yards.
Wall stone in place	130 yards.
Fills according to above estimates	1,149 yards.
Fills from rough, direct measurements	1,120 yards.
Average	1,135 yards.
1,135 yards at 64 cents (average price)	$727.57
$727.57 plus $17.32 (expense of culverts)	$744.89

THE STEAM DRILL

Steam drills are in common use in cities for grading and sewer excavation, quarrying stone for crushing, etc. They have not hitherto been considered as necessary or even desirable machines for smaller towns. With reference to them, the object of this experiment was (1) to determine whether they are adapted to work carried on by more or less inexperienced hands; (2) to see if the use of the drill as a portable machine for small amounts of work in a place is practically feasible.

While the work done was all within a limited area of a few hundred square feet, the arrangements were on a portable basis, and as a matter of fact, the whole apparatus was moved several times so satisfactorily as to amply justify more frequent

Digitized by Google

changes and removals to longer distances when necessary. Therefore, a detailed history of the experiment will apply as evidence to both of the above questions.

After consultation with various parties using drills, the writer, having had no practical experience with them, decided to place himself in the hands of some reputable party, handling a reliable article, and follow his advice. Such a party was found in the person of M. S. Harlow, M. E., New England agent for the Ingersoll-Sergeant Drill Co., with headquarters in Boston. After learning the nature of the experiment to be tried, Mr. Harlow loaned the college an Ingersoll B. drill that had been used a few times and yet was practically as good as new, so that the results obtained by its use were perfectly satisfactory. A man was sent from Boston to run the drill for such time as was necessary to teach those on the ground how to handle it, the college paying for this expense. With the exception of the loan of the drill, any other party would have been treated in the same manner by the drill company, and any machine sold would have been fully warranted.

EQUIPMENT

The following list of articles was found necessary for full equipment:

1 Ingersoll B. drill and tripod	$220.00
25 feet steam hose	15.00
1 set special blacksmith tools	8.00
Duplicate set octagon drill steel	16.00
Battery, leading wires, etc.	25.00
Extra fittings, bushings, sand pump, etc.	3.00
Portable 9-horse power boiler, with fittings complete	210.00
50 feet of 1-inch pipe in variable lengths with fittings	5.00
1 large and 1 medium Stillson wrench and 1 large monkey wrench	5.00
2 water barrels, pails, etc.	1.00
1 portable forge and anvil	24.00
Total cost	$532.00

Digitized by Google

PLATE 2.—ROAD BEFORE RECONSTRUCTION. *(From Photograph.)*

Digitized by Google

The prices given above are about those that will be accorded to any careful buyer. It will rarely be necessary for a town at the start to secure the boiler or the forge. In almost any town may be found small stationary boilers that may be hired at certain seasons and made portable by mounting upon any low truck. By putting a few dollars extra into steel, the blacksmith work may be economically done at any shop in town, a part of the drills being used while others are carried to the shop. The special blacksmith tools, however, will still be necessary. Under these circumstances, the necessary expense of outfit may be reduced to about $300.

The following force will be required to run the machine: one man for the drill; one man at the boiler; one blacksmith, or one boy to carry drills to shop; and one laborer working near to be called upon as needed. If either the man at the drill or at the boiler be a blacksmith, the drill may be run till all the steel is dull. Then shut down and sharpen up.

In the work now being described, the person who was to learn the use of the drill acted as assistant, and gradually was allowed to assume control of the machine.

In most cases, more or less stripping of earth from the rock is necessary. This should be thoroughly done well ahead of the drill, which may then be placed in the most advantageous positions.

WORK DONE

Seventy-four holes, averaging 3 feet, 3 inches, in depth, or 238 feet in all, were drilled in 67 hours, or at the rate of 3½ feet per hour. This time included one breakdown, using up 3 hours, and various delays due to seamy rock, stopping to instruct blacksmith, moving boiler, lack of steam, etc., but did not include 7 hours spent in blasting, 10 hours setting up and taking down twice each, and 1½ days, time of operator coming, going, and waiting for drill, all of which are included in the tabular expense account heretofore given. The rock drilled was syenite, exceedingly hard, quite seamy, and consequently slow drilling.

In comparison with hand work, not only is the amount done per dollar of expense more, but a class of work may be

Digitized by Google

attempted that hand work cannot touch, because of the depth to which the holes may be driven by steam power.

The total cost of handling rock, including the work with the drill, was very moderate, being at $1.11 per cubic yard less than the average contract price, which is usually about $1.75 per yard. With the experience gained, the work could be duplicated at a considerable saving of expense. Upon one job, carried on since with our own help, an average of 4 feet per hour was attained, with a labor account per day less than half that in the former case. One run of 8 hours gave 42 feet with 14 holes. These are not record-breaking results, but what has been actually done in very hard rock by amateurs.

NEED OF ROCK EXCAVATION ON COUNTRY ROADS

In order to investigate the question of the need of rock excavation on our country roads various computations were made, and a section of road 5½ miles long was carefully examined to find what amount of rock work was required.

1. Since it is evident from the table, page 62, that yard for yard rock excavation is much more expensive than earth fill, great care should be exercised not to handle rock when earth can be easily drawn to cover the same. In the experiment already related, if the grade had been carried two feet higher, thus avoiding all rock excavation except for sidewalk, the following computation would hold:

Extra embankment, 1,100 yds. earth, at 27½ cts. .	$300.00
Extra embankment for sidewalk, 51 yds. earth, at 27½ cts.	14.00
Total increase in expense	$314.00
Stone, replaced by earth at saving of 83⅓ cts. per yd., 181 yds., ...	151.00
Net saving by larger use of steam drill	$163 00

If a grade one foot higher than that adopted had been used, practically the same rock surface would have been covered and the total expense have been still greater. Therefore, as a mere matter of expense, a standard grade was attained in the best way.

Digitized by Google

PLATE 3.—AFTER BLASTING. *(From Photograph.)*

Digitized by Google

2. The examination of the 5½ miles of road referred to above showed at least fifty places where rock excavation is necessary, either to open up the side ditches so as to keep the water out of the traveled way or for the improvement of grade. No account was taken of the numerous cases where earth could be more cheaply drawn and thus save ledge excavation. This highway is about an average of the better class of country roads in the hill towns of New Hampshire.

RÉSUMÉ

As a result of both experiment and investigation it would then seem legitimate to draw the following conclusions:

1. There is need of a large amount of rock-work upon the average country road.

2. The steam drill is absolutely essential for the economical handling of considerable rock masses, and is capable of doing exceedingly economical work, in portable form, for small amounts of work in a place.

3. The ownership of the necessary plant, especially with boiler and forge omitted, is within the means of a large number of towns.

4. A good opportunity for starting such an innovation as above outlined may be found frequently in connection with the carrying out of some single large improvement involving rock excavation. In such case the total expense of plant may be saved the first season.

5. The obvious objections are connected with the lack of permanent organization of the department of roads and the frequent changes of management in our country towns. This is illustrated by the fact that probably two thirds of all the road machines in the state winter in the open air.

6. On the other hand, a steam drill is not bulky and would be left usually in the care of the person who had learned to run it. In that case it would receive all necessary attention.

7. A steam drill is simple in construction; is made to stand banging, and is less liable to get out of order than many articles of modern farm machinery in common use.

Digitized by Google

COMPARATIVE COST OF MOVING ROAD MATERIAL.

Different materials moved were as follows: Rock thrown out by blasting, rock from an old wall, clay from barn cellar, hard-pan full of bowlders and small stones, a small amount of cinders and gravel easily handled. For details of number of yards, length of haul, cost, etc., see table, page 62.

The cost of moving ledge rock is altogether too great to allow its profitable use in ordinary embankment. When, however, the rock must be moved, it can often be used to advantage in grading. Deep drilled holes, a good quantity of at least 75 per cent. dynamite, and a battery for use in exploding were found necessary for the satisfactory breaking up of masses of rock, while a hand derrick, which may be hired for about one dollar per day, was found to give far more economical results in handling rock than could be attained without. Without going into details, all these points are of special importance and can hardly be emphasized too strongly when rock-work is under consideration.

We see by examination of table that the economic value of an old wall for grade at a distance above fifty feet is exceedingly problematic. The size of the stone will be the determining factor. In the case under consideration, about two thirds of the stone had to be handled with bars and many stones were loaded upon the drag by aid of horses. When we consider further the additional expense required in packing the rocks together to make a fairly compact fill, it may be regarded as settled that it would be cheaper to draw earth at least one half mile than to utilize a wall of large stone over fifty feet distant.

The cost of handling earth varied from 15 to 66 cents per yard, the variation being largely due to the difference in the efficiency of the shovelers and not appreciably to differences in length of haul as great as one fourth mile. The highest cost, except for gravel, viz., 40 cents, was for earth moved only a little more than one fourth mile. Again, it can not be too strongly emphasized that the selection of the right number of shovelers and the right number of teams, proportioned to the distance to be covered and the kind of material to be moved, is a vital factor. I have in mind one third section of a town

Digitized by Google

PLATE 4.—LOWER SECTION OF ROAD PARTIALLY FILLED. *(From Photograph.)*

Digitized by Google

where most of the road work for several years has been done by a single team, sometimes with and sometimes without an extra shoveler. It would be hard to say which combination was worse for the town. While this is an extreme case, individual instances of such wasteful work are of daily occurence. Perhaps equally important is the size of the load drawn. It was found that an average team ought to draw on a main road, not too hilly and free from mud, at least forty feet or thirty-two bushels of earth. Yet twenty bushels or less than a yard is nearer the average load hauled by teams working for our towns.

Failure to attend to these details frequently triples the necessary expense. In this experiment, the cost of hauling earth and rock was less than the average cost to contractors and considerably less than the average cost to towns for road work. The clay moved from under the college barn had dried and hardened into an exceedingly compact mass, every inch of which had to be picked or otherwise broken up. Dynamite was tried several times quite successfully, but on the whole muscle and picks proved cheaper. With less effective muscle, however, the result might have been reversed.

A STANDARD GRADE

In reducing the grade of a hill to a standard of one twentieth or a little less, it was not expected that much additional light would be thrown upon the question of what a standard grade should be. It was a single example, and whether the college or the people of Durham thought this particular grade the most profitable or at all better than the old, is of little moment to outsiders. Towns, however, will go on cutting down their grades to about the proportions that the experience of Europe and of the more thickly settled portions of this country advises as fast as they get round to the point of making good roads, and this experience has been followed in the case under consideration.

It may be profitable, however, to notice some of the arguments employed by a few individuals to show that the new grade was no improvement over the old. It will be seen by Plate I, that formerly the grade was concentrated largely at two points, and it has been argued that this concentration

Digitized by Google

PLATE 5.—ROAD AFTER RECONSTRUCTION. *(From Photograph.)*

Digitized by Google

enabled a team to get over the elevation more quickly and easily than now with a longer hill having a uniform grade. In this case, there was no increase in the total length of road, rather a slight decrease, but only an increase in the length of the hill. There can be no question that, with the same road surface in two cases, a heavy load would steer clear of a grade of one eighth every time, and also of a grade of one twelfth for as great a distance as ninety feet, in favor of a uniform standard grade of one twentieth. Moreover, since it is found that a driving horse with a light load will trot steadily along on a standard grade and that a heavy load may be easily started upon such a grade, it remains at least doubtful whether the extra speed claimed even in the case of a medium-sized load on the concentrated grades is not taken out of the animal driven.

In riding a bicycle, it is noticeable that an ordinary rider may climb a hill at a standard grade without marked increase of effort, and with regular, steady motion, while upon a steeper hill, even if quite short, a special effort is necessary to get up sufficient momentum to carry one up the steep part, and this effort leaves one out of breath at the top, or, perhaps, only half way to the top. We think it is the same with the horse on the steep grades, and that the extra effort required to climb a hill quickly comes out of the reserve strength of the animal, and, therefore, is no real gain. It may be easier in some cases for the driver to concentrate his efforts at a few points while urging on the average horse but the owner of the animal would prefer the standard grade.

One fact was clearly shown as a result of the experiment, viz., that a hard surface may counterbalance a steep grade. After the completion of the grading a portion only of the hill was graveled, and that lightly. As a result the road was unusually muddy the following spring, and there is no doubt but that the harder surface with the steeper grade would have been preferable for the time. As the question of surfacing, at least as well as before work began, involves simply the expenditure of a few dollars for gravel, there is no argument there against reducing grade. It is important, however, as teaching the great utility, yes, even absolute necessity, of surfacing in order to procure good roads.

Digitized by Google

PLATE 6.—VIEW FROM TOP OF HILL AFTER RECONSTRUCTION. *(From Photograph.)*

Digitized by Google

ROAD SURFACING.

It was intended to carry out a series of experiments with different materials in surfacing, but so much effort was found necessary to complete the grading that only a small amount of work was done in this line. The main experiments were postponed, and mean-time a careful study of surfacing methods was entered upon in connection with the study of town management of roads, as specially exemplified in the town of Durham. Therefore, the little that was done will be considered in connection with the latter subject.

Digitized by Google

A PRACTICAL STUDY OF ROAD MAINTENANCE

BY CHARLES H. PETTEE

PRELIMINARY REMARKS

Conclusions drawn from actual practical work, when the surrounding conditions are carefully studied, are frequently very instructive. With this thought in mind, and with a purpose to accomplish as much as possible with the available college resources, the highway agents of the town of Durham were consulted, and, with their willing coöperation, the task was entered upon of studying for a year the work done by them, and of making report thereof, so far as lessons of public interest would warrant.

Infallibility in criticism is not claimed, and the writer is glad at the outset to testify to the honesty, ability, and general business acumen shown by all the members of the board of highway agents, and to the gentlemanly treatment accorded to himself and others with whom they came into business relations.

All personal criticisms* made, whether favorable or otherwise, are such as might easily apply to a large number of highway agents throughout the state, and refer to matters that generally need attention and correction.

ORGANIZATION FOR 1896–'97

At the town election in March, 1896, three highway agents were chosen, whom we will speak of as A, B, and C. A was reëlected and thus brought to the service of the town an experi-

*All personal criticisms made have been submitted to the individuals concerned, and are published with their consent.

Digitized by Google

ence and knowledge of previous work which was very valuable, and which tended to strengthen the growing conviction that highway agents should have a longer tenure of office than one year.

B also had had practical experience in working on roads and knew thereby how a well-surfaced road should be made. A and B worked together through the year without any division of territory or money.

C took about one third of the town for his territory, a certain portion of the total appropriation being set apart by agreement for his use. By this division an interesting illustration of both single and double management of roads was presented. As each proved successful in its way, it would seem to be pertinent to call attention here to the elasticity of our present law, by virtue of which it adapts itself to all sorts of conditions and personalities.

CRITICISMS

B knew how to make a good road surface. Conditions favored him in the early spring and he drew considerable quantities of gravel economically after the snow left and before the frost came out of the ground. This was spread where needed and worked into the mud as the frost came out, leaving as a result a remarkably hard and smooth surface. The best example of this work may be seen upon a hill on our main thoroughfare. The agent for the previous year had made an excellent and much needed beginning by drawing clay to reshape the road which here was practically washed out. The gravel which B put on in the spring was incorporated with the clay, making an extremely hard and durable surface, which was smooth through the summer, came out dry and hard in a remarkably muddy spring which followed, and has withstood the wash of heavy rains in an exceptionally wet season since. It is possible that some such combination of clay and good gravel will furnish the coming road for many sections of our state. It appears especially adapted to withstand washing on our hills, and when thoroughly underdrained remains dry and hard in the spring. The incorporation of clay and gravel in the spring seems to be unusually thorough and there-

Digitized by Google

fore desirable. The same result may frequently be accomplished at less cost by drawing gravel late in the fall, or by sled in the winter. In the latter case a double handling is generally necessary, which is not usually economical.

As a whole, A and B did not pay sufficient and prompt attention to little things. Such gullies as existed for months in numerous places on our main roads should have been filled up within a week of their formation. All catch basins should have been kept clear, and water should not have been allowed to run down the middle of the road on hills, while loose stones should have been picked up. Prompt attention to inexpensive details through the season will make and save more dollars than anything else. People enjoy riding over a smooth road. For best method of securing this attention to details, see "Highway laws," page 85.

If any great mistake was made in C's district it was the very natural and exceedingly common one of expecting to do more than could possibly be done with the money at hand, and consequently finding that the money would not hold out to go round. This error is quite excusable in the case of a zealous worker who takes up the business for the first time, as was the case here. It resulted, however, in an undue expenditure of money upon the roads first repaired, while others which in some respects needed it most had to suffer. It should be stated, however, that the main road through one half the district was put in fine condition and kept so through the season.

Another criticism, applicable, however, to the work of all three agents, was the method of use of the road machine in many places. Doing too much for mere smoothing and too little for the repairs really needed, it frequently created a nuisance by stirring up the traveled way and leaving it rough with sods, stone, etc. For details of what ought to have been done see "Road machines," page 81.

During the year considerable permanent work was accomplished, such as relaying the abutment of a bridge, rebuilding numerous large and small culverts, and improving the grade in several places, thus setting an excellent example for other towns to follow. In an average year with a fair appropriation, some permanent work always ought to be done. On the whole,

Digitized by Google

the roads of the town were distinctly improved as the result of the year's work.

C kept his accounts in a model manner. A pocket note-book showed at a glance, at any time, just what work had been done, with all amounts due on the same. It would be well if there were more such clear accounts of our public business in existence.

A and B kept their accounts well in hand, and knew—largely by memory—about what their outstanding bills were from time to time. They had, however, the usual horror of all book accounts outside of a single cash statement stating what had been paid, out. Where business has to be done upon a credit basis, as is the case usually in road construction for at least six months of the year, attention to outstanding accounts is imperative. It should be the business of some one to keep a record of all work done and every article bought, and report the same to headquarters systematically, not depending upon bills brought in after months have elapsed since service was rendered.

As a result of the special study of the roads of Durham, and of other roads for many years, the writer desires to add a few thoughts on each of several subjects.

ROAD SURFACING

Proximity to almost any kind of a gravel bank seems to be the most frequent controling element in deciding what material shall be used for surfacing. This gravel may be good, bad, or indifferent for its purpose, and the road follows suit, but the gravel is used all the same. While it is true that very excellent results may be attained by a proper admixture of even pure sand with a heavy clay soil, it does not follow that the sand alone would make a good surfacing material. I find a quite general disposition to use a gravel with too much sand in its composition. With heavy soils, at certain seasons, it produces fair results, but usually before it can become properly incorporated it is washed to the bottom of the hill or into the side ditches. Surfacing material is too costly to throw away in this manner. In all cases, the coarser material is more

Digitized by Google

durable and makes a harder surface, and at anywhere near the same cost should be preferred. Many times I have seen teamsters pass over the coarser gravel in a gravel bank because the finer shoveled easier. The incorporation of somewhat uniform stony gravel with clay on a well-drained foundation gives a surface in some respects superior to macadam.

ROAD MACHINES

Road machines are adapted to the work of the quick and economical removal of earth from the sides to the middle of roads, and they are excellent for smoothing up a rutted road, provided the blade of the machine is inclined backward instead of forward, as in common use. I will only speak of the former use. If it is necessary to remove earth to the centre from the sides, the road machine may be profitably used, but it is not always desirable to do this to a road. A road surface should be hard, smooth, and properly shaped. Months of travel are frequently necessary to consolidate the material on a road surface. This should not be ruthlessly torn up or covered with sods and sand each year, for the sake of making people think that something is being done. In ordinary cases, outside of villages, we cannot obtain grade in any way so cheaply or well as by the employment of a road machine, but when a piece of road is once taken in hand, a thorough job should be done.

The road should be properly shaped clear to the side ditches, and then covered with sufficient good gravel to smooth over and bind together the sods, sand, stones, etc., brought in from the ditches. In any country town raising on the average $25 or more per mile, I would not use a road machine upon a main thoroughfare without following with the cart to cover sods, stones, etc., with good surfacing material. If I could not do a whole road one year, I would do the worst places first, especially the hills, rounding them up and obtaining as hard a surface as possible. I would leave the completion of the work for the following year. Thereafter, with the occasional exception of repairing damages by freshets, etc., I would keep the road machine largely at home, doing enough each year, and each season of the year, with the cart, or simply with the

Digitized by Google

shovel, to hold the road where it has been placed. On level or nearly level ground, this work will be found very slight, provided only a good surfacing material is available and the traffic is not of the largest amount or heaviest kind. The constant passage of stone and other heavy teams is very trying even to a good road.

Hills, particularly steep ones, require constant attention and expenditure; hence a strong argument in favor of permanently cutting down grades.

The shape of the road-bed is important. Usually one of two extremes in using the road machine is met with. Either the operator is afraid of cutting down the hips of a road, and so leaves a ditch on each side inside the main ditch, which very commonly results disastrously, especially on hills; or else the hips are cut entirely down, leaving a steep, rounded shoulder which narrows up the way, exposes the surface to unnecessary wash, is frequently positively dangerous for passing teams, and allows the road, in homely phrase, to squat out at the sides. The surface should be a straight line from the centre to the side ditches, with a suitable grade to each side adapted to the longitudinal grade of the road, being more crowning as the hill is steeper. If the hips are in the way, cut them down just enough for the grade and no more. Be sure to carry the grade straight from centre to inner edge of ditch; frequently to bottom of ditch when elevation of road-bed or drainage does not require an extra depth to these appendages.

HIGHWAY LAWS—THE OLD AND THE NEW

During the recent session of the legislature of New Hampshire, an effort was made to return to the old district system of highway management. This attempt failed, but was supported by many of the rural communities because of dissatisfaction with the working of certain features of the new law. As both the old and the new laws are very generally understood, it will not be necessary to quote them entire in commenting upon certain portions of them here.

There were two features of the old law, so frequently vicious in their practical working, that it is doubtful if it were wise for any town to readopt them. One of these, viz.: the clause

Digitized by Google

allowing taxes to be worked out in labor, has been frequently discussed, and that with varying expressions of opinion.

The other, which made the district the unit for raising highway money, and in general for expending it, was, at times even more vicious in practice, and, what is more, its evil was not generally recognized. Let us examine the practical working of these two features of the old law. Under the first, the district highway surveyor was at the mercy of his employés, who many times would work only when it was convenient, and as they chose, frequently not working at all. Shrewd men, not desiring to work out their own taxes, sold the privilege to their neighbors for so much on the dollar. If coaxing failed to secure the tax in some form, other means, though lawful, were rarely resorted to. In short, the tendency of this part of the law was evil, and if it had not been for another excellent and restraining feature, would long ago have proved unbearable. Again, the district was the unit, and, as a rule, taxes were assigned to the districts where they were assessed. A special effort had to be made, and therefore was rarely made, to take money from one district into another. If important roads in some poor district were going to pieces the selectmen would allow the surveyor money raised for general town purposes to help him out rather than offend other districts by withdrawing what they were accustomed to look upon as their own. Quite a number of back country towns, with large road mileage, find it a serious burden to raise $15 per mile of road per year; $25 to $30 is perhaps a fair average of our country towns. A few come up to the limit allowed by law of $50 per mile. Our cities, acting under charters, may expend several hundred dollars per mile of road and still not be taxed at nearly as high a rate as the small town which raises the $15. While the expense per mile for construction and maintenance increases rapidly with the larger traffic of the village or city street, this increase is nowhere near in proportion to that in resources. There is no difficulty whatever in convincing any fair-minded person that money ought to be taken from these large centres and expended upon the roads in the country towns, and the demand for this is just. It is one of the fundamental arguments in favor of

Digitized by Google

some state system of highway construction. Frequently, however, when we ask the individual, who formerly lived in a favored highway district, with taxes in many cases not more than half worked out, to apply the same principle to his own town, he does not look at it in the same light, but will be found calling for a return to the old law. I have talked with numerous men, most of whom were well-informed and intended to be fair-minded and just, who have complained bitterly because the new road law took away so much of their highway tax. On further inquiry, I have found in several instances that such parties had been living in some of these favored districts that had been kept up at the expense of other portions of their towns. It will take a generation to fully outgrow the effects of this system, and meantime every reasonable effort should be made to clearly set forth the unfairness of any law which practically would require the expenditure of highway taxes in the districts in which they are assessed.

Let us turn now and look for some of the better features of the old law. I do not hesitate to say that the best feature—that which mitigated, and perhaps in many instances entirely suppressed, the general tendency to evil, was that which gave us the district unit for the expenditure of highway money. Let it be clearly understood that I do not mean the district system for raising money. The town itself is too small a unit for this purpose, but it is the best we can obtain at present. The old law went too far in expending all the money by the district plan, but experience has proved that the people desire to have some one in each neighborhood who has authority and a reasonable amount of money for making all the ordinary small repairs as they are needed throughout the season.

Let us consider for a few moments what an ideal system of road maintenance within a town would be. Without doubt, it would consist in the selection, possibly by the board of selectmen, of a practical road builder, who should devote his entire time to a study of the needs of the town and to the superintendence of all the work done. This is the method adopted in the city and in a few of the largest towns. It is not applicable to the country. In many, many towns the total money raised for roads would not pay the salary of a man who was skilled in

Digitized by Google

road construction and maintenance. The ideal system, then, is out of the question. Evidently, therefore, we should seek the aid of that man in town who best understands the problems involved; who is practical in carrying out his ideas, and who is willing to devote some of his time to the public without expecting to make a business for himself out of it.

How best can such a man be found? Some say by appointment of selectmen; others by election. I will not pretend to answer this question. In the long run, I would quite as soon trust the people as the wisdom of a board, though not always by any means. In any case, after appointment, he should have the selection of sub-agents; should have the power to remove them for cause, and preferably, should be allowed to arrange the several districts under the limitations of the law which should require the appointment of such sub-agents with jurisdiction covering not more than four miles of road each. Monthly statements by each sub-agent of all work done should be required, payment for same being conditioned upon the presentation of such reports within a specified time. All large repairs, including necessary running of road machine, extensive repairs to bridges and culverts, gravelling sections of road, grading hills, etc., should be done only under direct supervision of road agent or by his special order.

The great advantage claimed for this system is that a partial application of it has worked well in practice. In short, the salvation of the old law was the small district in which the surveyor had a personal interest and pride, and which in many instances impelled him and those working with him to work with extra fidelity, and in many cases extra time to get the roads into suitable condition. Lack of supervision, however, and power to concentrate a portion of the funds in special districts, prevented all extensive improvements under the old law. Under the new, there is nothing to hinder the appointment of sub-agents, but practically this has been largely prevented; (1) by the election of three highway agents in each town. With only one third the money to expend, most agents have been unwilling to divide the money further by sharing with sub-agents this expenditure. (2) Even when one agent has been given a whole town, he has usually felt it his duty to

Digitized by Google

personally superintend about all the work done. This has frequently caused delay in attending to needed repairs, and often entailed needless expense on account of distance traveled, particularly when so few of those elected road agents have been specially fitted for their work. Under these circumstances, the people have been uneasy and jealous of the absorption of so large a per cent. of the road money by a single individual and frequent changes in the personnel of the office have been the rule.

An amendment to our present law which would limit the number of highway agents to one, and which would compel this one to appoint an average of not less than one sub-agent for each four miles of road, with other limitations already indicated, and with permission to towns to adopt this amendment or not as they chose (it might not be advisable for a few of the larger towns) would do more to popularize the present law than anything else I could suggest, and would restore us in improved form that feature of the old law which in the present state of evolution of road construction and repair, is about the only one worth preserving. The recent amendment placing the highway agents under the selectmen seems liable to be of doubtful utility. While it may in some instances prove a needed restraint, is there not danger of unnecessary friction in placing one set of elective officers absolutely over another with whose appointment or discharge they have nothing to do? The selectmen should by law be compelled to thoroughly audit the accounts, including all outstanding accounts, of road agents at least every three months, and not a dollar should be allowed them above what has been voted. In emergencies arising after road money is expended, necessary repairs should be made directly by the selectmen. The great objection to the present law arises from the concentration of so much power and patronage in so few hands, when those elected have so little fitness for the work, and merely use the office to draw as much money as possible into the pockets of their families and themselves.

No law should define too closely the duties of the sub-agent. He should be under the highway agent and amenable to him. The law should imply a wise, general but inexpensive supervision by the chief. It might be expected to work in practice

Digitized by Google

something as follows: With an ordinary or even weak man at the head it would amount to a division of the money among districts, with the advantage of a distribution each year according to the needs of the several parts of the town. With a strong man at the helm the work would be systematized and co-ordinated, and real progress would be possible. In any case, as the sub-agents would be appointees of the highway agent, and presumably his friends, they would to some extent assist and restrain, while being in a state of mind open to conviction as to practicability of new methods suggested by their chief. In this way progressive views would make rapid progress, and we should have growing up in each district men who were really competent to manage the roads of a whole town.

A good highway agent should be allowed more than one year of service. In three years he ought to prove what was in him. Under the limitations above suggested it would be reasonably safe to require a two-thirds vote to proceed to the election of a highway agent on each of the two years following the election of such agent. Otherwise he might hold his place unmolested.

Finally, we should strive to perfect the present law rather than work backwards. The strong point in its favor, as it stands, is its elasticity. Under it a town can have the best system if it elects the right man, but this very elasticity has proved a strong temptation to selfish men to use the office for their own advantage, and therefore I feel that some amendment restricting or distributing the power is advisable. Until it is amended we may perhaps wisely use our influence with our agents to experiment in some of the directions I have outlined.

PUBLIC OPINION ON HIGHWAY MAINTENANCE

On the whole, it is my judgment that people in country towns expect too much of highway agents. Unable or unwilling to pay the price of skilled labor, and usually unwilling to allow any one person to remain in office long enough to learn by experience, our citizens often think that if only they could take hold a different showing would be made. When they try it, they find it is not easy to make a great advance with from $15 to $40 per mile of road. I am sure that the number in

Digitized by Google

any one town, who are competent to expend our road money, is quite limited, though, with all our faults, we make a better showing in economy than the cities. Some who are competent will not bother with the business. With all these drawbacks, it is not strange that numerous false moves are made.

The lack of sub-agents to properly present the needs of each small district, together with the meager records in our town reports of work done, leads many honest citizens living in neglected districts, or in those where the necessary amount of work is small, to conclude that very little work has been done anywhere. As a result, combinations are frequently made to elect men to represent new sections the following year. In this way many come to think that they have been specially elected to put their own districts in order, which they immediately proceed to do, looking after their own personal interests while they have the opportunity. Of course such a spirit is detrimental to the interests of a town. The appointment of sub-agents would remove much of this trouble. Moreover, great gain would result from the concentration of public opinion upon some broad-minded man of good judgment in selecting assistants; having the ability to work through these agents, while holding them to a strict accountability; a person to whom this work would be incidental, and not the main source of livelihood; preferably one who had no team that he desired employed a large portion of the time.

Digitized by Google

Sci 1636.35

Bulletin 47 October, 1897

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

STRAWBERRIES IN NEW HAMPSHIRE

Test of Varieties Notes from Growers Cultural Notes

Brandywine

Clyde

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Agriculturist and Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

STRAWBERRY GROWING IN NEW HAMPSHIRE

BY F. WM. RANE

Of what value is the strawberry crop to the state of New Hampshire? It has been our purpose to obtain data along this line during the past season. After much inquiry, travel, and study in the interest of the strawberry, we have concluded to present the following bulletin, believing it will be somewhat helpful in bringing this very deserving fruit into still higher favor.

Although strawberries can be found upon our markets much earlier than we can raise them, and at very moderate prices, it does not seem to hurt the markets for our own fruit. People purchase sparingly of these early fruits, waiting for those that are home-grown for the festivals and canning period. There is a certain loyalty to home-grown fruits. Eaten in season they are better relished and more wholesome.

There can be no question but that the strawberry is a paying crop in the northern part of the state, when properly handled. They are late, thus coming when others are not available.

Experiments with this fruit were begun at this station one year ago the past spring, when fifty-four varieties were selected and planted in our trial grounds. The plants were given only ordinary care. During the fruiting period we were visited by many strawberry growers, who pronounced the test of great value.

Digitized by Google

FIG. 2.—Sorting Brandywine berries, just as they come from the patch.

Digitized by Google

I

NOTES ON THE FIRST YEAR'S TESTS AT THE EXPERIMENT STATION

During the past season we fruited fifty-four varieties. The list selected was thought to contain the cream of the varieties grown. The soil is a sandy loam, fairly fertile, and at a medium elevation. The ground was not prepared until the previous spring, at which time a turf was turned under, and a good dressing of complete commercial fertilizer applied and harrowed in. At least one dozen plants of each variety were set in rows three and one-half feet apart and eighteen inches in the row. They were trained to the medium matted row system. They made only a fair growth during 1896, a number being unable to set sufficient plants to promise an average yield this season. The mulch used was pine needles. Data has been taken of all varieties, but with a few exceptions will be reserved until the results from the same varieties are taken another season. A new bed was set last spring, containing a row of each of the fifty-four varieties, and as the season as well as the ground has been more favorable, we expect to be able to report more in detail another year.

The first general picking of varieties was made on July 2d, at which time the photographs shown in Figures 3 and 4 were taken. Each box shows the comparative quantity of fruit from one picking, as well as general character and size. Figures 5 and 6 contain the remaining varieties, taken July 7th.

Leaf Blight was very common and troublesome. While all varieties are subject to it, some succumb much more readily than others, although handled and treated similarly. It was thought that the percentage of blight as affecting each variety upon our trial grounds would be of interest; consequently data were taken as given in Table 1.

Table 1 also has been worked up by Mr. A. Z. Norcross, a student in the agricultural course, to show other general characteristics of each of the varieties as they have appeared in our test, as (1) character of foliage and size of leaf, (2) ability to propagate itself by means of runners, (3) ability to form a matted row, and (4) general remarks.

Digitized by Google

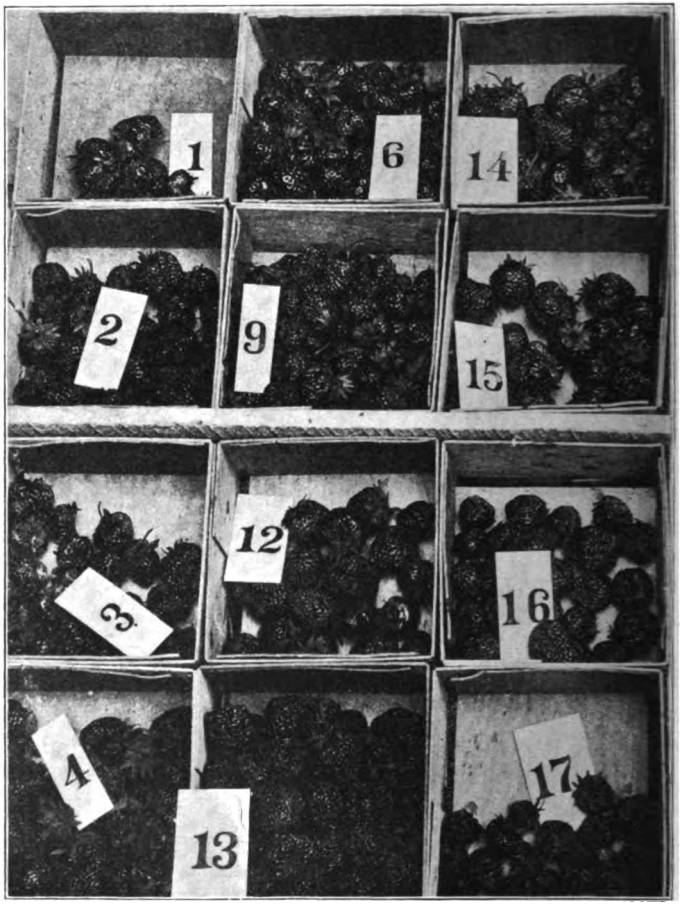


FIG. 3.—Varieties. Photographed July 2, 1897.

Bubach.	Warfield.	Bisel.
Crescent.	Cyclone.	Saunders.
Greenville.	Barton's Eclipse.	Splendid.
Lovett.	Beverly.	Berlin.

Digitized by Google

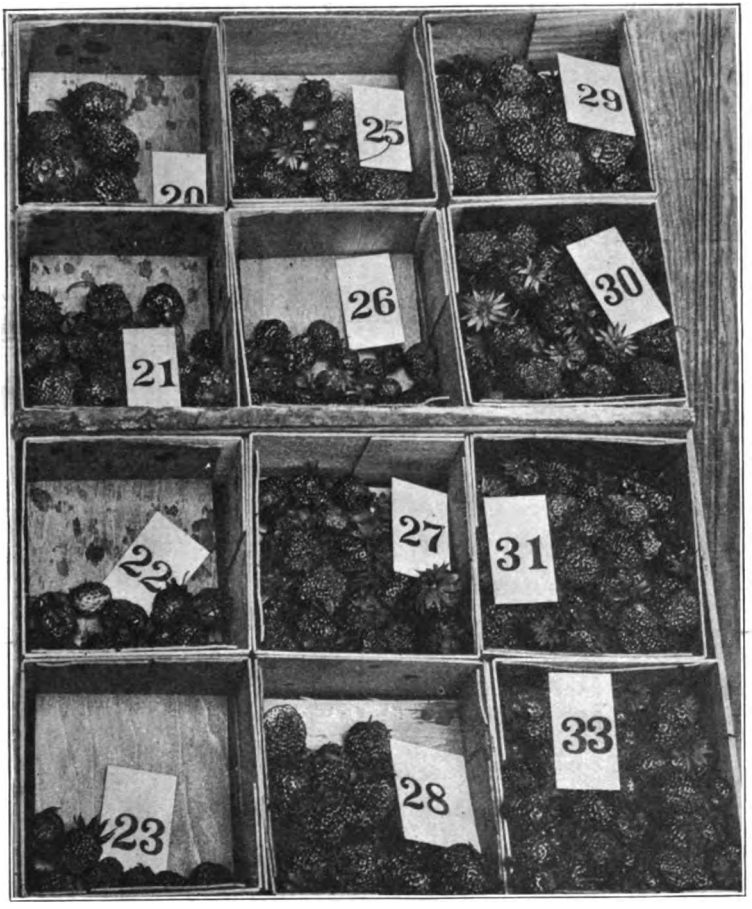


FIG. 4.—Varieties. Photographed July 2, 1897.

Enormous.	Beede No. 1.	Clyde.
Fountain.	Tuffs.	Enhance.
Gardner.	World's Champion.	Haverland.
Homestead.	Wm. Belt.	Ivanhoe.

Digitized by Google

TABLE 1

Comparison of the Plants of Varieties

No.	Variety.	Size of Leaf.	Number of Runners.	Matted or Not Matted Row.	Amount of Blight.	Remarks.
1	*Bubach	Medium	Few	Not	Slight	Old plants good.
2	*Crescent	Small	Fair	Narrow	Little	Foliage light. Plant not vigorous.
3	*Greenville	Medium	Not many	Loosely	Little	Foliage light.
4	Lovett	Medium	Few	Not	Slight	Foliage light to medium.
5	Parker Earl	Medium	Few	Not	Much	Old plants good and large.
6	*Warfield	Medium	Fair	Matted	Little	Plants small.
7	Brandywine	Large	Many	Wide matted	Much	Foliage heavy. Plant vigorous.
8	Brunette	Large	Few	Medium	Little	Plants large, but few resemble No. 34.
9	Cyclone	Medium	Many	Matted	Slight	Plants vigorous and many.
10	Leviathan	Large	Few	Matted	Slight	Plants vigorous, foliage spreading near ground. Suited for hill culture.
11	Marshall	Large	Fair	Matted	Much	Large plants, 7 in. Good for hill culture.
12	*Barton's Eclipse	Medium	Many	Thickly	Slight	Plant vigorous, foliage heavy.
13	Beverly	Large	Many	Thickly	Slight	Plant vigorous, foliage very heavy.
14	*Bisel	Small	Many	Matted	Much	Plants small, foliage spreading.
15	Saunders	Small	Many	Thickly	Much	Plants small.
16	Splendid	Medium	Many	Matted	Little	Foliage stands 7 inches.
17	*Berlin	Large	Few	Loosely	Much	Foliage medium.
18	Champion of England	Large	Fair	Loosely	Little	Foliage heavy, resembles No. 11.
19	Eleanor	Small	Fair	Narrow	Slight	Plants small.
20	*Enormous	Medium	Fair	Loosely	Slight	Plants vigorous.
21	Fountain	Medium	Fair	Matted	Little	Foliage 7 inches high.
22	Gardner	Large	Fair	Matted	Little	Plants fair size.
23	Homestead	Small	Few	Not	Little	Plants few and small.
24	Mineola	Medium	Many	Thickly	Little	Foliage stands high.
25	Beede No. 1	Large	Few	Loosely	Little	Plants large and vigorous.
26	Tubbs	Small	Few	Loosely	Much	Plants small, foliage light.
27	World's Champion	Medium	Many	Matted	Little	Foliage heavy.
28	Wm. Belt	Medium	Many	Matted	Very much	Plants large, spreading.
29	Clyde	Medium	Many	Thickly	Little	Foliage erect, 7 in. high.

Digitized by Google

TABLE 1—*Continued.*

No.	Variety.	Size of Leaf.	Number of Runners.	Matted or Not Matted Row.	Amount of Blight.	Remarks.
30	Enhance	Medium	Many	Matted	Little	Plants large, foliage heavy.
31	Haverland	Medium	Few	Loosely	Slight	Plants medium size.
32	Muskingham	Small	Few	Not	Little	Plants small and few.
33	*Ivanhoe	Medium	Many	Loosely	Little	Foliage not heavy.
34	Leader	Medium	Fair	Thickly	Sligh	Plants vigorous. Short and broad leaf.
35	*Princess	Medium	Fair	Loosely	Little	Foliage not heavy, like No. 34.
36	*Princeton Chief	Medium	Many	Matted	Much	Foliage heavy.
37	Wolverton	Small	Fair	Matted	Very much	Plants small, foliage heavy.
38	*Timbrell	Medium	Many	Thickly	Little	Foliage heavy, 7 in. high.
39	Rio	Medium	Many	Thickly	Little	Plants good, foliage heavy.
40	Columbian	Medium	Many	Thickly	Much	Foliage heavy, standing high.
41	*Holland	Medium	Many	Thickly	Much	Foliage heavy, standing 7 in.
42	Lady Thompson	Medium	Fair	Loosely	Little	Plants large.
43	Paris King	Medium	Many	Thickly	Little	Foliage heavy, standing 7 in.
44	Wilson	Small	Many	Thickly	Little	Foliage heavy.
45	Annie Laurie	Medium	Few	Not	Little	Plants large, resemble No. 34.
46	Bouncer	Medium	Fair	Thickly	Much	Foliage heavy, standing 7 in.
47	Glen Mary	Medium	Many	Thickly	Little	Plants large, stands over 7 in.
48	Brooks Seedling	Small	Many	Thickly	Little	Plants small, foliage light.
49	Gaudy	Medium	Many	Matted	Little	Foliage heavy.
50	*Jersey Queen	Medium	Fair	Not	Little	Foliage not heavy. Old plants large.
51	Cumberland	Small	Many	Thickly	Little	Foliage heavy, Leaf like No. 34.
52	*Jewel	Medium	Many	Matted	Slight	Plant vigorous.
53	Jessie					
54	Fremont					

*Pistillate varieties (imperfect).

Digitized by Google

FIG. 5.—Varieties. Photographed July 7, 1897.

Parker Earle.	Leviathan.	Leader.
Brandywine.	Marshall.	Princess.
Brunette.	Champion of England.	Princeton Chief.
Cyclone.	Mineola.	Woolverton.

Digitized by Google

FIG. 6.—Varieties. Photographed July 7, 1897.

Timbrell.	Lady Thompson.	Brooks Seedling.	Jewel.
Rio.	Paris King.	Gaudy.	Jessie.
Columbian.	Bouncer.	Jersey Queen.	Fremont.
Holland.	Glen Mary.	Cumberland.	Eleanor.

Digitized by Google

DESCRIPTIVE NOTES ON POPULAR VARIETIES

Beverly (perfect flower).—Medium to large fruit, of good form and color. Plant vigorous, heavy foliage, and sets many runners. The berries are large at the beginning of the season, but do not seem to hold out well. This variety is very well known by all growers in the state.

Brandywine.—This is a perfect flowering variety, which seems to be gaining favor wherever it has been thoroughly tried. On our grounds during the past season it proved to be one of the best medium to late sorts. The general opinion of growers is that although it does not excel in productiveness, its other good qualities make it valuable. While it does not yield as heavily as some of the medium early varieties, it equals the late sorts, and surpasses most varieties in size, color, and general appearance. The plants are very vigorous, large, set plenty of runners, and fruit freely. The berries are very large, and of regular, broad, conical form; bright glossy red in color, which extends to the center; flesh firm and excellent in quality. The fact that it is a perfect flowering variety together with the other good qualities named gives it a prestige which renders it worthy of a general trial.

Brunette (perfect).—Large, healthy leaves, but sets few plants. Berry, medium to large, uniform and regular; color, dark red; form, conical to roundish; season, second early. Not very productive this season.

Buback (pistillate).—This variety is considered very valuable and is commonly grown. The objection to it is that it sets few plants. Where given the best of attention it responds liberally. It is well adapted to hill culture. The berry is large, broad conical and sometimes flattened in form; color scarlet, fair quality, season medium.

Clyde (perfect).—A promising new variety. It showed up well in the test this season; plants vigorous; berries medium to large, fairly firm, good quality; form, conical regular, uniform; color, light scarlet with a whitish center. Leaf medium; sets many runners, makes a well formed matted row, and is little troubled with blight. Foliage stands erect; berries are about the right size, maintaining it throughout the season.

Digitized by Google

The only drawback to the variety is on account of color and perhaps firmness. It deserves a trial.

Crescent (pistillate).—An old standard variety still planted extensively. Berry small, bright scarlet, moderately firm, fair quality; form, conical. Ripened first on June 22d and extended over a long season. Productive.

Greenville (pistillate).—A popular variety in this state. Berry large, dark red, medium firm, fair quality; form, broad conical. Medium leaf, loosely matted row, little blight, season second early.

Haverland (pistillate).—An old variety still commonly grown, but discarded by many on account of softness. Good for a market near at hand. Plants were medium size and formed a loosely matted row; leaf medium, dark green, with long stems; berry, large, long conical. It was productive and healthy during the past season.

Lovett (perfect flower).—A variety grown by most growers and valuable as a fertilizer of such varieties as Crescent and Haverland. Berry large, firm, good quality; form, long conical; color, bright red. Plants strong, healthy, and productive. Runners comparatively few during the past season, leaf medium, very little blight.

Marshall (perfect).—From a two years test this variety has shown itself to be hardy, vigorous, and fairly productive. Berry, large to very large, medium firmness, high quality; form, rather irregular; color, deep red. A very desirable amateur variety. It lacks in texture and productiveness, causing many to discard it. For a fancy trade it is well worthy of consideration.

Parker Earle (perfect).—The berry was small and not up to its reputation this season; probably our ground was not rich enough. It is generally conceded to be a very valuable late variety when given high culture and plenty of moisture.

Warfield (pistillate).—A popular variety in the state. Has a comparatively long fruiting season, makes numerous runners which need thinning, and requires plenty of moisture to get best results. Berry medium to large, firm, good quality; form, conical; color, crimson. Generally liked.

Digitized by Google

II

NOTES FROM LOCAL GROWERS.

During the strawberry season we made it a point to visit and procure data from many of our local growers. Accordingly, Mr. George F. Beede's place at Fremont was visited by myself; and afterwards, Mr. Hunt, my assistant, visited and obtained the data herein given from the following named growers: Messrs. J. C. Piper, Stratham; G. S. Tuttle, Barrington; James Hayes & Son, Dover; George D. McDuffen, Dover; Mr. C. B. Flanders, Concord; W. H. Allen and G. A. Tripp, Dover. This is only a partial report of a few of the leading growers. It is hoped that all other strawberry specialists will favor us with their addresses.

The growing of strawberries is a question which we have found the growers carefully studying each for his own good. Although there are some minor differences as to the varieties, due perhaps to the surrounding conditions, yet as to the fundamental principles of the care and management, all are in unison. In interviews with many leading growers in different parts of the state, they have given their methods of cultivation, which have aided us very materially in reaching general conclusions on strawberry culture throughout the state.

Strawberries have been most successfully grown on a rich clay loam which has had a liberal application of barnyard manure or commercial fertilizer; yet in some instances it appears that too much has been added and the plants have sacrificed fruit for foliage. However, it is our opinion that on most of the strawberry land the application of manure will greatly aid in the productivity of the plants. Strawberries are known to require considerable moisture, and unless it is found naturally in the soil it must be applied, in order that the plants may be in a vigorous state of growth until after fruiting time. If the plant is small and weak it cannot be expected to give the amount of fruit that a vigorous one would. At the time of setting and ripening of fruit a large amount of water is taken up by the plants, and this, of course, has to be supplied by the roots from the soil.

Digitized by Google

Irrigation is very enthusiastically advocated by J. C. Piper of Stratham, who says it has paid immensely; the crop was much larger and the berries were first class. Varieties like the Crescent maintained their full size until the very last picking, and all the fruit which set ripened into well-developed berries. This may be a surprise to many growers, for it is known that nearly all varieties become smaller towards the close of the season.

The distances for planting depend upon the soil, growth of the plant, and method of cultivation. Mr. Piper for a while set his plants in rows three, three and one-half, and four feet apart, but last season beds were planted in which the plants were fifteen inches apart, omitting each third row; also others where every fourth and every fifth row was omitted. No runners were allowed to grow. G. S. Tuttle of Barrington finds it best to set his plants three and one-half by seven feet and placing two or three plants in each hill. The fields are then cultivated both ways by horse power, and after a time the plants are allowed to run, forming rows in which the hills are seven feet apart. Every one of the growers visited is decidedly in favor of clean cultivation. W. H. Allen of Dover says thorough, clean culture upon soil liberally fertilized with a light mulch for winter has given him good fruit every year; and this seems to express the sentiment of other growers throughout the state.

Mulching through the winter meets with much favor, and in connection with clean culture and irrigation has made a decided change in the problem of strawberry raising. It has paid as well as irrigation. A plot left unmulched last winter has not yielded one-half the fruit of mulched areas. Although the plants lived, the line of mulch was distinguishable at a distance all through the season,—foliage was weak, pale, and scant; leaf and berry stalks short and weak; consequently but little fruit.

As to the varieties, there is a difference of opinion and always will be as long as berries are grown; but the practical growers quoted agree upon the merits of the following varieties:

(1.) Bubach, Crescent, Lovett, and Warfield.

(2.) Greenville, Haverland, and Beverly.

Digitized by Google

(3.) May King, Sharpless, Marshall, and Michel's Early. Brandywine and Clyde seem to be gaining general recognition.

Mr. Beede is probably the veteran grower of the state, and is recognized as an expert. He has produced some very good seedlings. One hundred and fifty varieties is not an uncommon number for him to grow. His market berries, however, are always limited to a few varieties of his choice. We consider ourselves fortunate in being able to present the following data, which enables us to give a history of varieties during the past five years.

1893 Report.—"Out of a great number of varieties tested this year twelve proved to be very good, among which are the Beder Wood, Beverly, Bubach, Crescent, Haverland, and Warfield. Eureka was quite productive, but the berries were very small and light colored. In the order named Beder Wood, Warfield, Crescent, and Haverland were the earliest, Beverly and Parker Earle the latest. The most profitable, Beverly, Warfield, and Crescent. The most productive, Haverland and the last three named above. The largest in size, Bubach, Beverly, and Barton's Eclipse. Out of a long list of novelties and newer varieties which have proven very promising we have the Brandywine, Cyclone, Greenville, and Marshall."

1894 Report.—"I need a good-sized, bright, showy berry, firm enough to stand up and look well a day or two after picking. The following proved best for me this season: Barton's Eclipse, Beverly, Bubach, Cyclone, Lovett's, Parker Earle, and Warfield. I still plant Crescent and Wilson to a limited extent for their productiveness, but they are too small to go in a selected list. I have rejected Beder Wood for softness and small size in last pickings. Haverland, I regret to say, must go on account of softness. For near market it is one of the best, and must be included in a list of the best five for all purposes. All things considered, Beverly, Bubach, Haverland, Lovett's, and Warfield are the best five varieties. For the most profitable, Beverly and Bubach are still in the lead as they are also the largest in size. Enhance, Eureka, Great Pacific, and Shuster's Gem were productive, but too soft or light colored. Swindle was very productive, late, firm, and good color, but the foliage failed before all the berries ripened. Saunders, fine and productive, better adapted to home use than for market. Seventy-nine others were grown, but do not find them valuable enough to retain. Among them are Gandy, Jessie, Jewell, Jucunda, Improved, May King, Michel's Early, and Sharpless. Of the new varieties, those that are strong, vigorous growers, with healthy foliage, are: Bisel, Carrie, Hunt's No. 3, Ivanhoe, Mary, Rio, Robinson, Splendid, and Tennessee Prolific."

1895 Report.—"My strawberry crop the past season was more than an average one. By a high location I nearly escaped the frosts in May, which came after blossoming. Some of the most tender varieties were slightly damaged. My beds were all heavily mulched with meadow hay. The ex-

Digitized by Google

perimental beds of new varieties were very satisfactory in one respect, the plants were in the best of condition, giving much value to a one year test.

"The test of another year shows no reason to change the select list, excepting two additions. Barton's Eclipse, Beverly, Bubach, Cyclone, Lovett's, Parker Earle, and Warfield, with Brandywine and Greenville, proved best this season. Beverly and Brandywine gave plenty of fine berries late in the season, and they were sold in the market as late as July 15, and had plenty for home use a week later. Rio and Afton were the most promising new early varieties, though Afton is too small for market.

"After a second year's trial, Brandywine, Cyclone, Glen Mary, and Greenville, apparently, are good enough to go into the select list. Glen Mary and Greenville are a little off in quality, though no poorer than Bubach or Haverland. They give such an abundance of large, showy berries, that they must prove favorite varieties. Timbrel was large, very productive, and of best quality, but not liked at home or in the market for its light and spotted color, Berries in the shade were all pure white when ripe; I have no use for it. All other varieties tested the second year were not desirable."

1896 Report.—"The test of another year shows no reasons to change the list of standard varieties. I shall discard Cyclone, Parker Earle, and Warfield from extensive planting: Cyclone for uncertain bearing, the others for small size. I shall add Clyde, reserving the point of color for future testing; that is, I shall not set it very extensively if its color proves a serious fault. It is described in most catalogues as dark red or dark scarlet, but it does not show up that way here, and the rows are narrow,—eighteen inches wide.

"New beds were much injured by an open winter. Old beds, especially of Beverly and Brandywine, were productive. My market for fruit is becoming educated and I cannot, profitably, set many varieties of small size and poor quality. For these reasons, Crescent, Parker Earle, Warfield, and Wilson of standard varieties are discarded. Haverland is too soft for one to handle. Varieties of large size like Bubach, Glen Mary, and Mary lack quality for my customers. I want varieties good enough so there will be a call for them the second time. Clyde is so large, perfect in form, firm and good quality, that it will please all that get acquainted with it, but it will not be a berry that will sell on sight like Belmont, Brandywine, and Marshall. This is my opinion of Clyde for a fancy market. I know of no staminate variety more productive, so I would advise all that want a good fertilizer for pistillate varieties to give it a trial.

"I tested, in 1896, for the first time about seventy-five varieties. Judging from one season's trial, Clyde will easily be worthy of a place in the list of select varieties. Annie Laurie, Aroma, and Brunette are desirable for home garden. Gandy Belle (same as No Name and Isabella), Enormous, Paris King, Fountain, and Staples have many points of value for market purposes, but a few standard sorts are better. Ruby (No. 6), received for trial from E. A. Riehl, Alton, Ill., is worthy of thorough trial. Perfect plant, very large. handsome fruit, fine color, quality, firm. Apparently not productive enough for common market. See's No. 1, from H. S. and A. J. See, Geneva, Pa., is very early, and all right every way excepting size. It is too small to

Digitized by Google

be valuable. Seedling A, from Rev. E. B. Stevenson, Freeman, Ont., is of more than average value."

1897 Report.—"Old beds, bearing the second year, were very productive. New beds were good, especially Brandywine and Clyde. Heretofore I have been inclined to think rust on the plant was wholly a weakness of the plant. It is a well-known fact that some varieties, like Lovett and Clyde, never rust, are, so to speak, rust-proof. This season gave me a new lesson. *All varieties were free from rust;* even Wm. Belt was clear and healthy in leaf, and the quantity of very large, fine fruit was equal to the most productive pistillate varieties like Haverland, Warfield, and Bubach. The same with the staminate varieties, Clyde, Lovett, and Beverly. Carrie (pistillate) seedling of Haverland was fine in every respect. For fine color, shape, and quality, I know of no variety equal to Brandywine for my location, either for family use or fancy market. The pickings are uniform, season late and long. The bushels at the end of season tell the story.

"Beverly, Brandywine, Bubach, Greenville, Lovett's, and Warfield are the leading varieties with me. Haverland, Barton's Eclipse, and many other productive varieties prove too soft for my market. I picked Brandywine on July 9th, a very hot day, sent to market the 10th, the last of which were sold the 14th and were in fine order.

"I tested for the first time this season Bismarck, Bouncer, Gulick's No. 7 and No. 8, Duncan, Howells, Hurlburt, Hayes' Eclipse, Anna Kennedy, Ideal Oriole, Ocean City, Maxwell, Michigan, Sparta, and Tennyson. Gulick's No. 7, excellent in all points; Sparta, not productive; Bismarck, coarse and poor quality; Bouncer, similar to Miner's Prolific and Beverly, but not so productive. We shall soon lose sight of the others.

"I have to fruit for the first time next season Hall's favorite, Margaret, McKinley, Mele, Ridgeway, and Seaford.

"We have varieties of mid-season and late that are close to perfection. The great lack is a very early variety. I had great expectations of Rio. It blooms freely, is early, large, good color, firm, and best quality, but the blossoms blight badly and give only two or three pickings."

Figures 1, 2, 3, and 4 were all taken when visiting Mr. Beede's place on July 2d, 1897. Figure 2 is a cool, dark, well-ventilated packing-shed. The berries are the Brandywine, which Mr. Beede prizes very highly. They are shown just as they come from the field without grading, all being above the average size, highly flavored, firm, and of good color. He grades them simply by turning from one box into another, picking out the small and inferior berries.

Should the reader desire further information on strawberry growing from Mr. Beede himself, he is referred to a paper presented before the Plowman's meeting in Boston, Feb. 29, 1896, published in the *Massachusetts Plowman*, March 7, 1896.

Digitized by Google

III

CULTURAL NOTES

This being the first bulletin from the station on the strawberry, the writer finds it necessary to discuss the cultural directions in order to meet a number of inquiries already at hand, as well as to place before others such information as is likely to be desired.

The same general principles hold true in strawberry culture, whether grown for home use or the market.

Soil and Fertilizer.—Strawberries do well on almost any well-drained soil, reasonably fertile and at a fair elevation. A friable clay loam gives the best results if properly managed. Fall plowing, together with a liberal application of fertilizer and thorough cultivation, ensures a greater degree of success. There is little danger of making the soil too rich, the only precaution being an understanding of the action of the commercial fertilizers, as there are possibilities of injury when used in large quantities close to the plant. A thoroughly well-rotted manure is an ideal fertilizer, but where the soil contains plenty of humus, as in the average garden, wood ashes and ground bone give good results. Where wood ashes are not to be depended upon, sulphate or muriate of potash will do as a substitute, using a proportionately less amount (ordinarily one-tenth as much). The soil having thus been plowed and mulched, it is left in this condition until spring. The next step is to fit the land to receive the plants, which is done with the cultivator, harrow, and roller.

This plan is the one to be practiced at the station. Strawberries, however, are often planted at other seasons of the year, August being considered by some the best month. What has been said of the proper conditions of soil for the spring planting applies equally well here. The soil should be in condition to receive the plants early to ensure success. A good plan is to use the land from which some hoed crop has been taken. The soil is then in a fine degree of tilth. The white grub (*Lachnosterna fusca*) and a few other insects are so frequently troublesome where strawberries follow sod that few people ever

Digitized by Google

practice it. The crop is usually preceded by some cultivated crop such as corn, thus eliminating the trouble from both insects and weeds. A crop of clover or other green manure known to be free from these troubles will, when plowed under, prove of great value to the crop. Coarse manure also may be turned under with good results, provided it is applied early enough to be well decomposed and mixed with the soil by planting time. The objection to manure on account of its contamination with weed seeds is easily overcome by better cultivation and preparation before planting.

Commercial fertilizers are commonly used for strawberries. Where the crop is grown in the rich garden soil, the results are quite marked; but where grown on a field scale, they are not as valuable as good barn-yard manures. No rule can be given for the proper application of fertilizer per acre for successful strawberry growing. Every soil is necessarily different from every other as regards physical, mechanical, and chemical properties. From study of the soil in question it is thought that with the aid of the following table one can judge from previous experience as to what should be considered a liberal application.

The New York station recommends the following table of fertilizers for the strawberry.*

For nitrogen....	(1). 150 to 300 lbs. nitrate of soda, applied during the growing season; or (2). 125 to 250 lbs. sulphate of ammonia; or (3). 250 to 500 lbs. dried blood.
Phosphoric acid.	(1). 550 to 1100 lbs. bone meal; or (2). 375 to 750 lbs. dissolved bone, etc.; or (3). 450 to 900 lbs. dissolved rock.
Potash	(1). 140 to 280 lbs. muriate; or (2). 140 to 280 lbs. sulphate; or (3). 550 to 1100 lbs. kainit; or (4). 1400 to 2800 lbs. wood ashes.

Setting Plants.—The best time for setting the plants, as stated, is in the early spring. By so doing the plants become thoroughly established, and if given proper cultivation and training usually ensure a maximum crop the following season.

*New York Agricultural Experiment Station, Bulletin No. 94, New Series.

Digitized by Google

FIG. 7. NEWLY SET PLANTS (GEO. F. BEEDE).

On the other hand, plants started in pots in the spring are often set out in late summer or early fall. Although this latter system is quite a popular one, only from one-third to one-half the crop is obtained the first season. Its advocates, however, show that by so doing, a previous hoed crop may be obtained. Pot-grown plants cost more than the ordinary field-grown.

No plant needs more care in transplanting. The crown should be on a level with the soil, no lower, no higher; the roots should not be allowed to get dry. Dip them in water when they begin to get dry. Trim the roots back at least one-third and spread them fan shape when setting, filling in gradually; firm well.

Distance apart to set plants depends upon how they are to be trained.—There are two methods of setting out strawberry plants commonly practiced, each of which depends upon the proposed system of training. These are (*a*) Hill culture, which, as the term implies, consists in growing each plant by itself in a hill, not allowing the runners to grow or flowers to

Digitized by Google

set the first season. This causes each plant to become stalwart and large, and where properly grown are very productive the following year. The plants are usually set in rows three feet apart and one foot apart in the row. This method is little used by commercial growers on account of its requiring too much time to keep off the runners. Where one has a small garden and desires to make a fine display, hill culture will prove of value.

(*b*) Matted rows. This is the method commonly used by commercial growers. The plants are set in rows varying from three to four feet apart, and from fifteen to eighteen inches apart in the row. When the runners start they are either placed or allowed to run at will. When well set they form a continuous matted row. The grower can suit himself as to just how wide the row should be and train accordingly. After having blocked out the row, cut off the runners to keep them within bounds. When the row is about twelve inches wide it is termed the Narrow Matted Row, and when about double that width, the Wide Matted Row. To get the finest berries the runners should be thinned out at some time during the season. It is a good practice to do this after the rows are formed for fear that drouth, insects, etc., may assist. Where plants are fall set, comparatively few runners form. The plants should not set any fruit the season they are transplanted, which is prevented by picking the flower clusters.

Bearing Period.—Just how long a bed should be kept in bearing seems to be a disputed question. Commercial growers are generally agreed that from the dollar and cent standpoint, more is made from the fruit of the first season than any other. It is larger, plants are less troubled with insect enemies and diseases, and it costs less to plant a new than clean out an old bed. While this is generally advocated, it is not universally followed, as many growers hesitate before turning under a patch that looks well and promises fair returns for a second crop. That the fruit of the second season is earlier has been proved, also that the varieties fruit more readily; but because of their inferiority in size are less profitable.

The variety has a marked influence upon this question; in fact if some were not grown for two years, they would be dis-

Digitized by Google

carded without a fair trial. But with the majority, where the berry is only of medium size the first season, as is the case with many of our market varieties, it naturally follows that they will be inferior the second year. Another reason for fruiting the second and third seasons is to ensure a crop, as some years plants do not set new runners abundantly.

Where the bed is retained it is necessary to clean out the rows as soon as the last fruit is gathered, properly cultivating the intervening soil. Some practice burning over the plantation before cultivation. To do this mow off the tops of the plants and burn. Rust, insects and old mulch are thereby destroyed. This is done as early as possible to give the plants an opportunity to form new leaves and fit themselves for winter. While this method is often successful more experience is required to manage the plants than with the renewal system.

Mulching.—It is necessary to protect strawberry plants with some material during the winter to prevent trouble from freezing and thawing. The plants are perfectly hardy and capable of withstanding freezing, but some soils are liable to heave; and the mulch remedies this. It serves not only to prevent heaving but in fruiting time to keep the berries clean, and to conserve moisture. It is usually applied as soon as the ground freezes sufficiently to bear up a wagon and team. The material varies in different places, that most easily obtained at a minimum price ordinarily being used. Coarse manure, marsh hay, pine needles, pine boughs, clean wheat straw, leaves where held in place with some other material, etc., are the most common. Just what to recommend is a question, depending upon the nature of the soil, etc. Always avoid a mulch containing weed seeds, as it often costs as much to clean out the weeds as it would to purchase the more expensive material. In the spring the mulch may be left between the rows or drawn off, giving an opportunity for cultivation. Ordinarily, however, experience would say not to remove it, as it serves to retain moisture.

Perfect and Imperfect Flowers.—It is a matter of importance that all strawberry growers know the difference between these two classes of flowers. The perfect or bi-sexual blossoms contain stamens or male organs and pistils or female organs.

Digitized by Google

FIG. 8.—Harvesting the crop; first season wide matted row (Geo. F. Beede).

Digitized by Google

The imperfect or pistillate blossoms contain pistils only. It is necessary to know before transplanting what varieties are pistillate in order to plant perfect flowering sorts near enough to ensure fertilization. One row in every two to four of the pistillate sorts is sufficient. The pistillate varieties usually yield more heavily than other varieties when well fertilized.

SUMMARY.

1. Southern grown berries do not come into competition with home-grown fruit.

2. The culture is the same for berries both for home use and the market.

3. The strawberry does well wherever given good cultivation, proper drainage and plenty of fertilizer in available form.

4. Well-rotted manure, bone meal, and wood ashes (or some of the potash salts), are considered the best fertilizers.

5. Fall plowing, mulching with manure and thorough preparation of soil before setting plants are the first steps in strawberry growing.

6. A crop of clover or other green manure known to be free from insects will when plowed under prove of great value to the crop.

7. Coarse manure may be plowed under with good results, provided it is applied early enough to be well decomposed by planting time.

8. Spring set plants give the best results; where fall set they should be grown especially for that purpose, small pots being most commonly used.

9. Where plants are grown by hill culture they are usually set in rows three or three and one-half feet apart, and one foot apart in the row; all runners and blossoms being kept off the first season.

10. In matted rows, the rows are from three and one-half to four feet apart and plants are set from fifteen to eighteen inches in the row, according to variety and width of row.

11. Fruiting one season only is usually advocated by best growers. It is less work and more profitable to set a new bed than renovate an old one.

Digitized by Google

12. It is necessary to protect the plants in winter by mulching with some material such as straw, marsh hay, pine needles, pine boughs, coarse manure, etc., to protect from heaving.

13. Failure to get a maximun crop frequently comes from improper fertilization. Have at least one row in every four, of a perfect flowering variety.

14. The practical growers quoted agree upon the merit of the following varieties:

(1). Bubach, Crescent, Lovett, Warfield.

(2). Greenville, Haverland and Beverly.

(3). May King, Sharpless, Marshall, Michel's Early.

Brandywine and Clyde seem to be gaining general recognition.

15. Irrigation has proven of great value wherever tried.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 48 **November, 1897**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

NINTH ANNUAL REPORT

BY CHARLES S. MURKLAND

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE. A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director*.
FRED W. MORSE, B. S., *Vice-Director and Chemist*.
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist*.
HERBERT H. LAMSON, M. D., *Bacteriologist*.
CLARENCE M. WEED, D. Sc., *Entomologist*.

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Agriculturist and Horticulturist*.
CHARLES D. HOWARD, B. S., *Assistant Chemist*.
WILLIAM F. FISKE, *Assistant Entomologist*.
ELWIN H. FORRISTALL, B. S., *Superintendent of Farm*.
CLEMENT S. MORRIS, *Clerk*.

The Bulletins of this Station are sent free to any resident of New Hampshire upon application

Digitized by Google

NINTH ANNUAL REPORT

The ninth annual report of the New Hampshire College Agricultural Experiment Station, for the year ending November 1, 1897, is hereby respectfully submitted. The reports of the departments will be found upon the pages indicated in the following list:

Financial Statement	117
Report of the Vice-Director	119
The College Herd	120
Department of Agriculture and Horticulture	122
Department of Entomology	138
Department of Bacteriology	146
Department of Meteorology	148

CHARLES S. MURKLAND,
Acting Director.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ending June 30, 1897.

RECEIPTS

Cash received from United States treasurer	$15,000.00

EXPENDITURES

Cash paid for salaries	$7,378.70
labor	2,392.36
publications	787.60
postage and stationery	84.61
freight and express	172.78
heat, light, and water	519.59
chemical supplies	67 66
seeds, plants, and sundries	201.72
fertilizers	245.60

Digitized by Google

Cash paid for feeding stuffs	$665.59	
library	136.24	
tools, implements, and machinery	780.83	
furniture and fixtures	57.56	
scientific apparatus	168.84	
live stock	496.77	
traveling expenses	125.45	
contingent expenses	1.30	
buildings and repairs	716.80	
	$15,000.00	$15,000.00

SUPPLEMENTARY STATEMENT

RECEIPTS

Cash received from the State Board of Agriculture for analysis of fertilizers, also sundry fees for water analysis,	$1,243.00
Cash received from sales of farm produce	2,029.68
	$3,272.68

EXPENDITURES

Cash paid for salaries	$739.86	
labor	1,172.14	
freight and express	11.20	
chemical supplies	69.02	
seeds, plants, and sundry supplies	157.99	
feeding stuffs	145.46	
tools, implements, and machinery	78.42	
scientific apparatus	46.14	
live stock	698.67	
buildings and repairs	153.78	
	$3,272.68	$3,272.68

Digitized by Google

REPORT OF THE VICE-DIRECTOR

To Charles S. Murkland, Acting Director:

The work of the experiment station has been continued during the year, closely along the lines described in the last annual report. Its facilities for investigation have been notably increased by the privileges afforded in the new green-house, insectary, and cold-storage cellar constructed by the college from the state's biennial appropriation; and consequently the scope of its experiments for the coming year will be widened.

The station has co-operated with farmers in testing varieties of potatoes, with creameries in settling disputes about milk-testing, with lumbermen in studying the destruction of the spruce forests by insects, and with the State Board of Agriculture in the inspection of commercial fertilizers, the exposure of sales of oleomargarine, and in institute work.

The following bulletins have been published during the year:

No. 41. Potatoes, Varieties, Fertilizers, and Scab. By F. Wm. Rane and Leigh Hunt. Pages 1–14.

No. 42. Tomato Growing in New Hampshire. Notes on Tomato Breeding. By F. Wm. Rane and Leigh Hunt. Pages 15–26.

No. 43. Some Inferior Wood Ashes. By Fred W. Morse. Pages 27–30.

No. 44. The Canker Worm. By Clarence M. Weed. Pages 31–42.

No. 45. Fruit and Potato Diseases. By H. H. Lamson. Pages 43–56.

No. 46. An Experiment with a Steam Drill. Methods of Road Maintenance. By Charles H. Pettee. Pages 57–88.

No. 47. The Strawberry in New Hampshire. By F. Wm. Rane. Pages 89-114.

No. 48. Ninth Annual Report.

The following changes have occurred in the station staff:

On January 15, 1897, Mr. Ruel S. Alden resigned his position as assistant agriculturist and farm superintendent, and the scope of Mr. Leigh Hunt's work was enlarged to include it. Mr. William F. Fiske was appointed assistant entomologist on

Digitized by Google

March 21, and Mr. Elwin H. Forristall, of the class of 1897, N. H. C., was made farm foreman, on June 10. On the completion of the year, October 30, Mr. Hunt severed his connection with the station.

In the department of chemistry there have been employed temporarily, Messrs. Fred D. Fuller, Ernest B. MacCready, and Charles W. Vickery, their time being principally spent in analyzing fertilizers.

Following this may be found short reports of sundry investigations pursued by the different departments.

THE COLLEGE HERD

The following tabulated statement of the performance of the college dairy herd is presented with the belief that it is a creditable record. But little explanation is deemed necessary. The figures are taken from the daily and weekly records of the barn and creamery. The butter is calculated by the standard formula, butter=1 1-6 fat, instead of the actual weights obtained, since the latter would involve corrections for milk and cream sold. The herd milk was tested weekly by a composite daily sample.

Making no deductions, the herd has been equivalent to 284 milch cows and 51 dry cows for one month, and has produced 145,019 pounds of milk and 7,875 pounds of butter, making the average monthly yield per head for 335 cows, 23.5 pounds of butter and 24 cans of milk, or 282 pounds of butter and 288 cans of milk per year.

The only allowance to which attention is called is the fact that one fifth of the herd's equivalent has consisted of heifers in their first lactation period.

The herd is at present composed of 17 Jerseys, 7 thoroughbreds and ten grades, 6 Ayrshires, 5 Guernseys, 5 Durhams, 3 thoroughbreds and 2 grades, and 2 grade Holsteins.

Digitized by Google

HERD RECORD FROM NOVEMBER 1, 1896, TO OCTOBER 30, 1897.

Month.	Milch cows.	Dry cows.	Pounds of milk.	Average for milch cow.	Average for herd.	Average fat test.	Pounds of butter.	Remarks.
November....	21	10	7,792	371	251	4.85	440	
December....	19	10	9,975	525	344	4.7	546	Two cows sold.
January	23	6	10,748	467	371	4.75	595	
February	23	3	10,467	455	403	4.65	568	Three cows sold.
March.....	21	5	12,391	590	476	4.65	672	
April	24	2	11,955	498	460	4.85	676	One cow sold and one bought.
May..... ...	25	0	14,079	563	563	4.8	788	One cow sold.
June	24	1	13,855	577	554	4.55	735	
July.....	24	3	12,356	515	458	4.65	670	Two heifers calved.
August.....	23	4	11,024	479	408	4.6	591	Fat test lost, but estimated at 4.6.
September....	25	4	12,646	506	436	4.5	665	Two cows bought.
October.....	32	3	17,731	554	507	4.5	929	Two cows sold and eight bought.

Respectfully submitted,

FRED W. MORSE,

Vice-Director and Chemist.

Digitized by Google

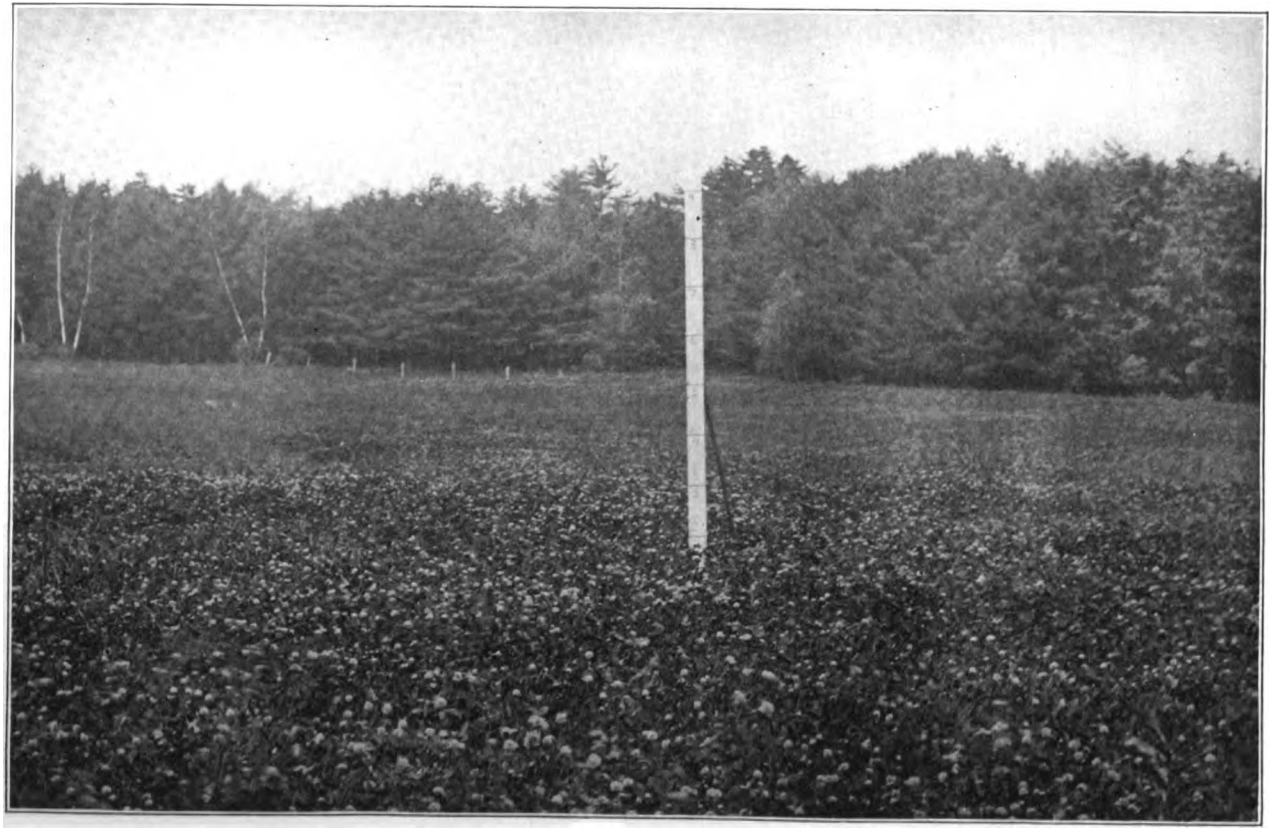


FIG. 1.— Field of Alsike and Red Clover in bloom.

Digitized by Google

DEPARTMENT OF AGRICULTURE AND HORTICULTURE

AN EXPERIMENT WITH CLOVER

During the past two years the growing of clover has been a success upon the college farm. This crop has been such a discouraging one in the past, and so generally abandoned, we give our method.

The two successful attempts at growing clover have come from spring seeding. One field after having been well manured, using seven cords to the acre of barn-yard manure, and in cultivation for ensilage corn the previous year, was plowed early in the spring of 1896 and fitted; working in during the process, with a cutaway harrow, 640 pounds of commercial fertilizer per acre. The fertilizer used contained the following mixture per acre: 170 pounds dissolved bone black, 170 pounds ground bone, 210 pounds muriate of potash, 45 pounds dried blood, and 45 pounds nitrate of soda.

The other field contained soil similar in every respect to the first, but did not contain a hoed crop the previous season. It was also plowed in the spring of 1896, and stocked, using seven cords of stable manure together with 85 pounds each of ground bone and muriate of potash per acre.

The seed used was three pecks of barley and the following mixture of grass seed, per acre: 5 pounds Alsike clover, 7 pounds choice Red clover, 5 pounds Red-top, and 12 pounds Timothy or herds-grass.

The soil is a heavy clay, but fairly drained, somewhat rolling, and typical of the grass-lands of this section.

Figure 1 represents a field just coming into bloom, which upon close examination shows the clover heads well divided between the Red and Alsike. At cutting time, in some sections of this field, three feet was not an uncommon height.

Figure 2 represents the harvesting of the clover crop during the past season. The average yield from this field was 4 tons, 1,097 pounds per acre. This weight includes both the first and second crops, which were 3 tons, 55 pounds, and 1 ton, 1,042 pounds, respectively.

Digitized by Google

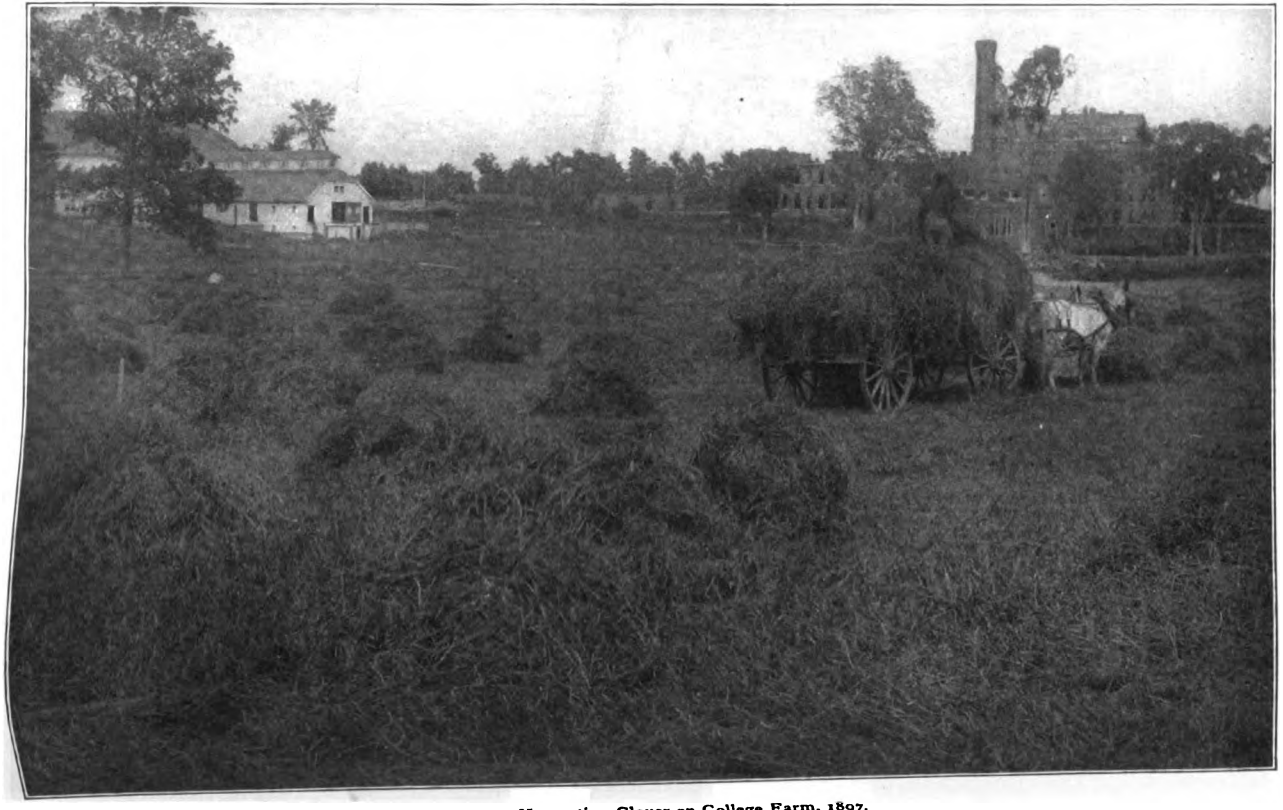


FIG. 2.—Harvesting Clover on College Farm, 1897.

Digitized by Google

Two large plots were measured out in each of the fields, representing similar conditions. The field upon which corn had been raised one year, and followed by stocking down with commercial fertilizers, produced at the rate of 4 tons and 835 pounds per acre. The other field, stocked with manure and some fertilizer, gave a yield of 4 tons and 1,360 pounds, the results being slightly in favor of the latter by 525 pounds per acre.

The past season was an exceptionally favorable clover year, barring the unfavorable weather for making hay; however, the preceding winter was rather severe upon newly stocked ground.

The fields seeded during the past season made a very fine showing; the rowen was very heavy, and was cut into the silo in September. When the barley, which was used for the protective crop, was cut for hay, the clover had made an excellent growth, as is shown in Fig. 3, being fully a foot high and very heavy.

POTATOES IN A WET SEASON

When publishing the potato bulletin last year, it will be remembered the Station offered a few potatoes of various varieties for test purposes to any potato growers agreeing to test them and make a report to the Station after harvesting this fall. To this offer the requests were too numerous for our limited supply. Over one hundred lots were sent out, which, as will be seen by consulting the accompanying map, were fairly well distributed over the state.

The season unfortunately having been a very poor one for the crop, we are without the data we had hoped to obtain. Where potatoes were planted on low land they were almost universally reported as complete failures. The average yield was far below what in ordinary seasons would be considered a poor yield. The rot was very prevalent everywhere. At the Station, not only the yield was small, but the potatoes as well.

Reports have been received from over one-half, locations being indicated by the cross (×) on the map, and these have all been gone over to see if any general conclusions could be arrived at. In nearly every consignment, four varieties thought to have merit were included, in order to determine if possible

Digitized by Google

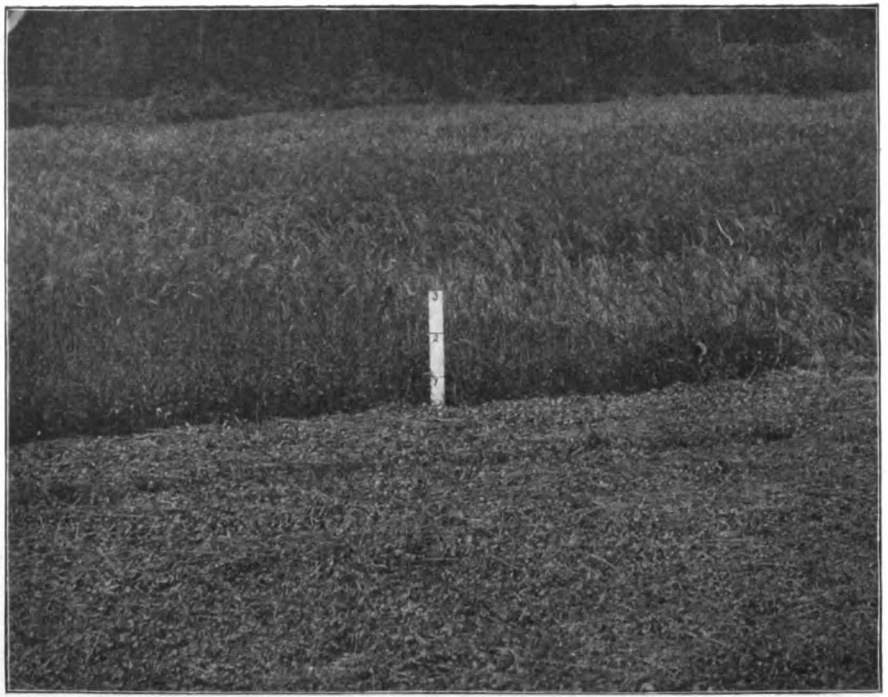


FIG. 3.—Spring Seeding, Clover with Barley, 1897.

Digitized by Google

the value of each, besides giving an opportunity to compare them under different conditions. These four varieties were, No. 2, American Wonder; 11, Carman No. 3; 57, Quick Crop, and 65, Sir William. They all showed marked superiority in our last year's test here at the Station.

Over fifty per cent. of the reports, where anything like a crop was harvested, give No. 65, Sir William, first place; next come No. 2. American Wonder, and No. 11, Carman No. 3, which stand about even, the former doing better on a loam, while the latter preferred a sandy soil. Quick Crop, while it was not mentioned by any one as giving the highest yield, was credited, beside earliness, with being second best by a great many. Another point very evident was that upon sandy soils the Sir William, with but a single exception, was the poorest.

All of the varieties tested last season were again grown this year, together with a number of new ones, making in all ninety-eight varieties. The new varieties under test for the first time were those numbering above eighty. The following table of yield is offered to show how the varieties behave under similar conditions, during a very unfavorable, wet season.

Digitized by Google

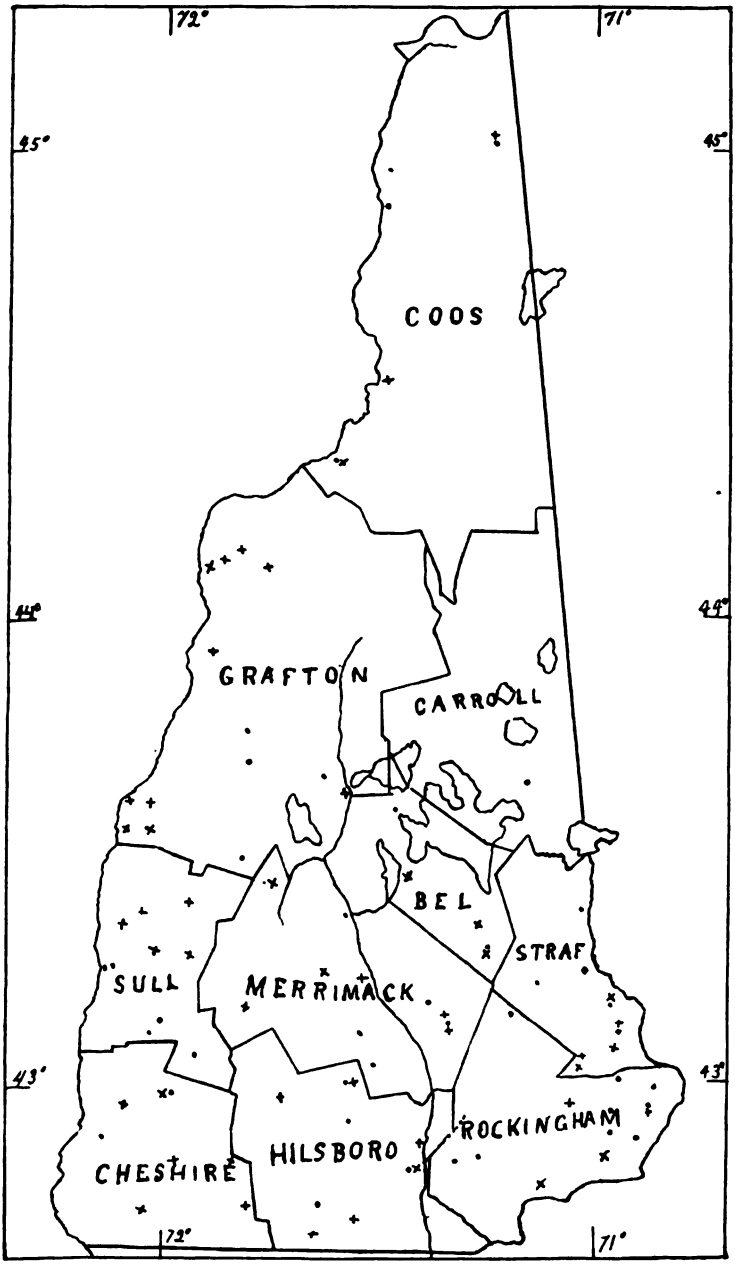
COMPARISON OF VARIETIES OF POTATOES.

(Yield per acre. Calculated from forty-eight feet of row, and thirty inches wide.)

Number.	Variety.	Yield per acre.	Number.	Variety.	Yield per acre.
1	Uncle Sam	202	50	Orphan	19
2	American Wonder	171	51	Parker's Market	216
3	Banner	115	52	Polaris	82
4	Blush	108	53	Peerless, Jr.	135
5	Brownell's Winner	106	54	Prize Taker	75
6	Burpee's Extra Early	108	55	Pride of Ireland	70
7	Burpee's Superior	114	56	Queen of the Valley	83
8	Bill Nye	207	57	Quick Crop	162
9	Bracy's Rising Sun	77	58	Reeve's Rose	188
10	Carman No. 1	280	59	Rochester Rose	73
11	Carman No. 3	25	60	Rupert's Perfection	139
12	Champion	40	61	Rutland Rose	181
13	Clark's No. 1	83	62	Rural New Yorker No. 2	90
14	Clay Rose	198	63	Rose No. 9	252
15	Crown Jewell	97	64	Seneca Beauty	146
16	Country Gentleman	118	65	Sir William	174
17	Delaware	145	66	Somerset	149
18	Dew-drop Rose	144	67	Salzer's World's Fair	96
19	Early Harvest	112	68	Victor Rose	212
20	Early Market	54	69	Vick's Perfection	151
21	Early Norther	70	70	Vaughan	161
22	Early Puritan	97	71	Vick's Advancer	71
23	Early Rose	82	72	White Star	113
24	Early Six Weeks	89	73	White Mountain	171
25	Everitt	47	74	White Rose	206
26	Early Fortune	103	75	Wilson's First Choice	218
27	Early Wisconsin	83	76	Woodhull's Seedling	133
28	Early Thoroughbred	115	77	World's Fair	243
29	Freeman	116	78	Woodbury White	172
30	Farmer's Alliance	92	79	White Ohio	162
31	Good News	103	80	Governor Rush	139
32	Great Divide	50	81	Sir Walter Raleigh	217
33	Green Mountain	89	82	Bovee	203
34	Harbinger	128	83	Pink Eye	122
35	Houlton Rose	73	84	Livingstone	128
36	Harvest Queen	139	85	Early Roberts	214
37	Howe's Premium	104	86	Fill Basket	293
38	Honeoye Rose		87	Buck's Chance	
39	Irish Cobbler	96	88	Prolific Rose	264
40	Irish Daisy	36	89	Pride of the South	283
41	King of the Roses	135	90	Early Michigan	199
42	Koshkonong	24	91	Algoma	303
43	Late Puritan	169	92	Alexander Perfection	303
44	Leonard's Favorite	65	93	Burns No. 1	294
45	Maggie Murphy	111	94	Snow Flake	37
46	Money Maker	54	95	Virgirosa	309
47	Mill's Endurance	59	96	King of the Earliest	181
48	New Queen	104	97	North Pole	119
49	Ohio, Jr.	75	98	Mill's Prize	152

Most of the growers have signified their intention of trying the same varieties another season, at the end of which time their notes, together with those of our own, ought to give us a considerable insight into the question of varieties as suited to our conditions. A number of the potato bulletins of last year,

Digitized by Google



Map showing points in the state where Potato experiments are being conducted.

Digitized by Google

discussing the varieties then considered, are yet on hand for distribution. The potato crop is well adapted to the state, and the best varieties to grow can be found out in no other way than by making a study of them under favorable conditions.

New Hampshire Fruit Calendar for 1897

Under this head the general subject of fruit-raising in the state may properly come. During the past two seasons a beginning toward a study of the pomological sections of the state has been made. Progress has been slow, although material is gradually coming to hand. We have been unable to get the addresses of fruit growers. A list has been begun, from the names of fair exhibitors and those attending Grange and farmers' institutes, as well as through the correspondence of the horticultural department. In a few years we ought to be able to know just what our fruit interests are. The Experiment Station requests that reports be sent from all who have had any experience in raising fruit of any kind in the state. When writing, please state just what fruit you are growing; also number of trees or area in small fruits as well as your experience with varieties, culture, spraying, etc.

The writer was judge on fruits at two fairs, the Interstate fair held at White River Junction, Vt., and the Merrimack County Grange fair at Warner; also a visitor at the Rochester fair. He has received a full report upon fruits together with specimens from Mr. G. F. Smith, superintendent of the horticultural department of the State Grange fair at Tilton. Notes from these sources, together with those from college students living in various sections, and correspondence as well, form the basis of this calendar.

The Apple.—After the over-abundant crop of 1896, it was not expected that apples would be plentiful this season. While they have been very scarce, the crop has not been a complete failure. Here and there farmers have had a few barrels to sell. Even the poorest apples, such as windfalls and wormy fruit, found a ready market in many towns. The display at the Interstate fair from New Hampshire was very creditable, considering the earliness of the season, August 24–27. The fruit

Digitized by Google

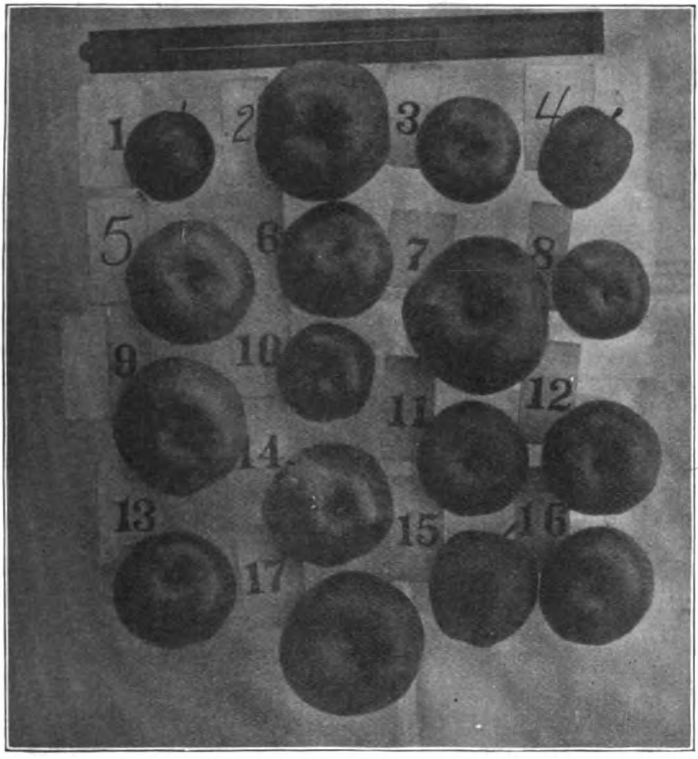


FIG. 4.—Apples from Meredith.

1 Early Strawberry,
2 Fall Pippin,
3 Fameuse,
4 Red Gilliflower,
5 Holland Pippin,
6 Jewett's Red (Nod-
7 King, [head),
8 Lady Sweeting,
9 Northern Spy,
10 Peck's Pleasant,
11 Roxbury Russet,
12 Seek-no-further,
13 Stark,
14 Twenty Ounce,
15 Yellow Bellflower,
16 Bethel Sweet,
17 N. Y. Sweet Russet.

Digitized by Google

was immature and not well colored. Five hundred plates were on exhibition, specimens of some of the leading varieties of which are shown in Figure 5. From consultation with some of the leading growers, it was concluded that there was about one third of a crop in this section.

1 Red Astrachan,
2 Yellow Transparent,
3 Early Joe,
4 Early Harvest,
5 Early Harvey,
6 William's Favorite,
7 Porter,
8 Maiden's Blush,
9 Peach of Montreal,
10 Sops of Wine,
11 Wagener,
12 Emp. of Alexander,
13 Juneating,
14 Bethel,
15 Sweet Russet,
16 Wealthy,
17 McIntosh Red,
18 St. Lawrence,
19 Fall Pippin,
20 King,
21 Hubbardston,
22 Nodhead,
23 Ben Davis,
24 Scott's Winter,
25 Yellow Bellflower,
26 Dexter,
27 Blue Pearmain,
28 Swaar,
29 Munson's Sweet,
30 Pound Sweet,
31 Lady Sweeting,
32 Westfield Seek-no-further,
33 R. I. Greening,
34 Tallman Sweeting,
35 Northern Spy,
36 Baldwin,
37 Roxbury Russet,
38 Fameuse.

At Tilton, Mr. Smith reports 850 plates of fruit as compared with 1,000 last year. The fruit was lacking in both size and quality, although there were many exceptions. Figure 4 represents a specimen of a few varieties from Mr. Smith's own place this season.

The apples at the Rochester fair were very imperfect, taking them as a whole. The number of varieties was quite representative but the fruit inferior, showing that it was impossible to secure average specimens for exhibition according to report. Not many new orchards were set. It is feared that too many rely upon trees far past their usefulness for a paying crop.

The Pear.—The season of 1897 has been to the pear what that of 1896 was for the apple. The exhibits at the fairs named were all of high standard, and contained many varieties. At Tilton, Mr. Smith says, "The exhibition of pears was equal, if not superior, to anything ever made in New Hampshire." Figure 6 contains a representation of fourteen varieties from the central part of the state.

The Peach.—The peach is grown in some sections of the state with success. The past season has been a peach year in New Hampshire. While it is true that there are not many

Digitized by Google

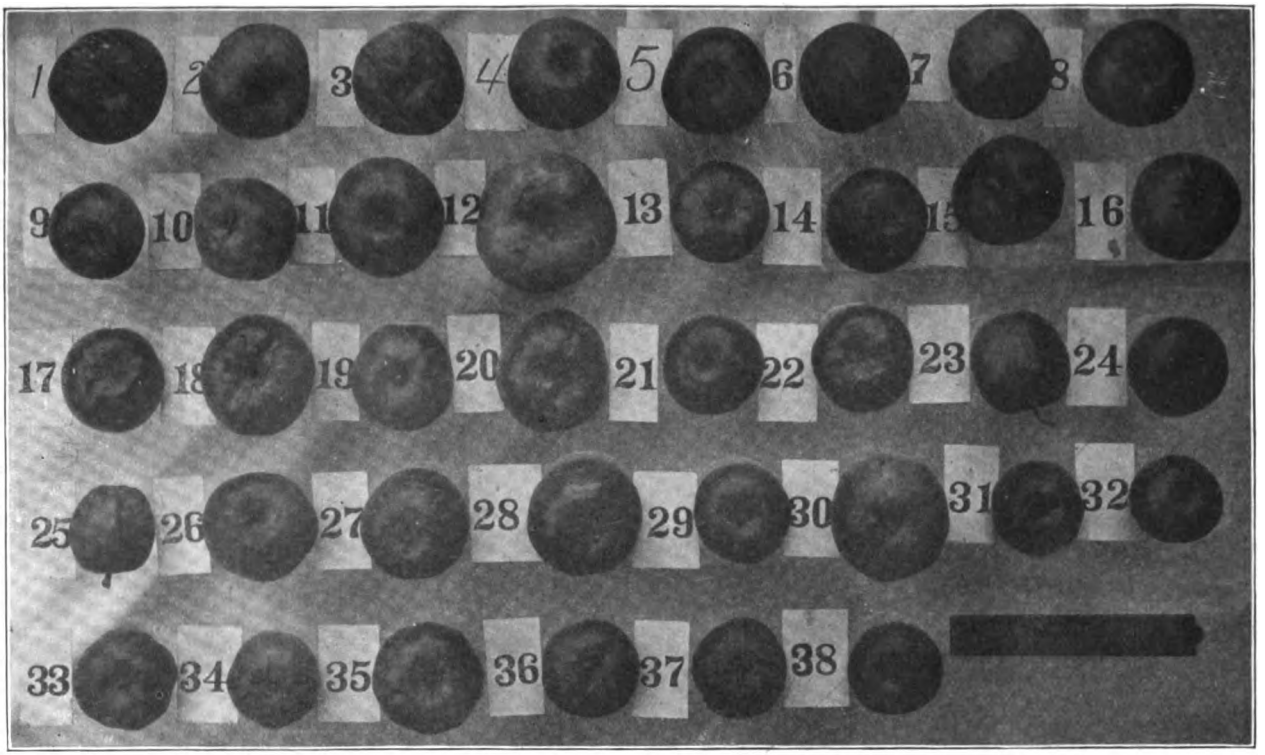


FIG. 5.—Apples from the Inter-State Fair.

Digitized by Google

extensive orchards, there seems to be an inclination toward growing more peaches. Several have set orchards this season. Nearly all trees bore fruit this year, even those very old and neglected. At the fairs the exhibits were exceptionally good, leaving out, perhaps, the display at Tilton; but even here one man, Mr. C. E. Pillsbury of Londonderry, exhibited twenty plates.

Upon invitation from Mr. Charles M. Stratton of Hollis, his peach orchard was visited on September 6, at which time he was picking and marketing his Mountain Rose fruit. A finer crop was never seen by the writer, even in the famous belts of Delaware or Western Michigan. His main orchard, which had been set but five years, contained 475 trees and has produced about 900 baskets of one-half bushel each. It was all marketed in Nashua and handled by one groceryman as fancy fruit. His other variety was the Early Crawford, which is a trifle later and equally as productive. A number of photographs were taken of the orchard, together with full notes upon his method of cultivation, etc., which together with notes from other sources will be published when sufficient material has been collected to warrant a bulletin on the peach. An excellent report was also received from Mr. G. S. Tuttle of Barrington, who has 1,500 peach trees representing numerous varieties, but he reports no crop this season. He says there are a few trees on his place that were set about forty-one years ago, which fact shows that the peach tree must be hardy in New Hampshire. To get the most out of peaches we believe they should be set often, thus using them more as a rotation on land. A few old trees, however, owned by Major Mellen of Durham produced a very heavy crop. These trees stand at least twenty-five feet high.

The Plum.—Reports from various sections regarding this fruit differ widely. In 1896 there was a very heavy crop in the section of Lake Winnipesaukee; at the State Grange fair, Mr. G. F. Smith of Meredith had on exhibition twenty-two varieties. Specimens of thirteen of these varieties are shown in Figure 7. This year there were no plums in this section. On the other hand, Mr. F. B. Hanchett of Plainfield and John Gould of West Lebanon report remarkably heavy crops. Re-

Digitized by Google

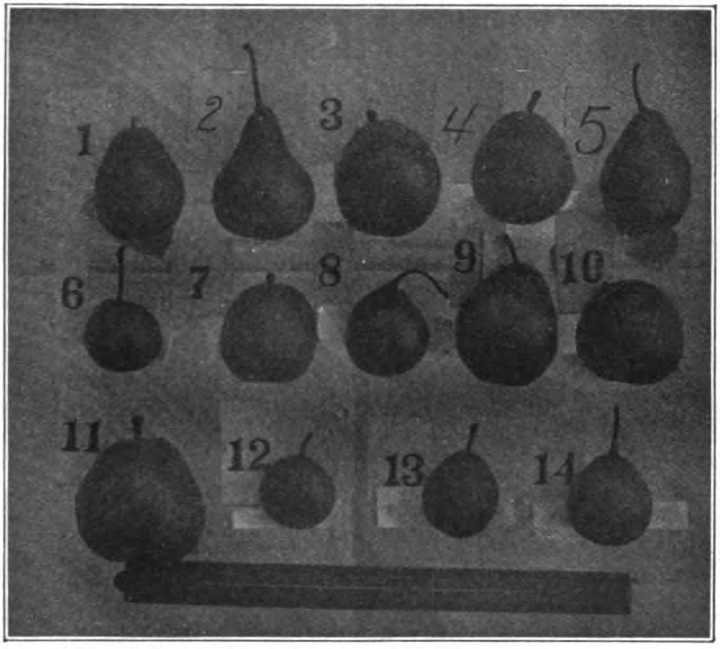


FIG. 6.—Pears from the central part of the state.

1 Lawrence,
2 Beurrè Bosc,
3 Beurrè d'Anjou,
4 Dovenné Boussock,
5 Louise Bonne of Jersey,
6 Winter Nelis,
7 Sheldon,
8 Tyson,
9 Bartlett,
10 Fulton,
11 Duchesse,
12 Seckel,
13 Buffum,
14 Belle Lucrative.

Digitized by Google

ports have also come from many plum raisers about Nashua, indicating a generally good yield throughout this section. The Lombard variety seems to be the general favorite. No reports have been received from elsewhere in the state. The Experiment Station has a young orchard which was set in the spring of 1896 containing a single specimen of thirty-five varieties. We expect to make additions from time to time. The plum, we believe, deserves more recognition as a fruit well adapted to our conditions.

Cherries.—It has been impossible to get any accurate idea of the cherry crop. Wherever seen they brought a good price. The common sour cherries brought 12½ cents per quart in this section of the state and there was a very limited supply. On July 5, the native sweet cherries were bringing 17 cents to 20 cents per pound upon the Portsmouth market, when the California fruit was only 25 cents per pound. I have yet to know of any of the Russian varieties of cherries being tried in the state. Cherries certainly should be made a success here. The failures of late are doubtless due to insects, and fungous diseases, which should be easily overcome. The Experiment Station intends to set out an orchard this spring.

Small Fruits.—The strawberry has already been considered in Bulletin No. 47 of last month, and the reader is referred to it for this fruit. Raspberries, both the red and black-cap varieties, do not seem to be grown under domestication to any great extent. Most of the fruit offered in many sections is that from the wild or native bushes, which cost only the time in picking. There was a fair crop of this fruit this season, and the demand was very good. It is understood that where this fruit is grown for market there is little trouble from the competition of the native fruit, even at higher prices. Blackberries, like raspberries, are found growing wild throughout most sections of the state. The crop this season was a heavy one, but, due to such a wet season, were watery and did not possess their usual flavor. The wild fruit doubtless affects the market for cultivated varieties, unless it is in the larger cities where a taste has been cultivated for the latter. Currants were very plentiful late in the season, but earlier they seemed to be very scarce. All bushes, even those which have had a bitter

Digitized by Google

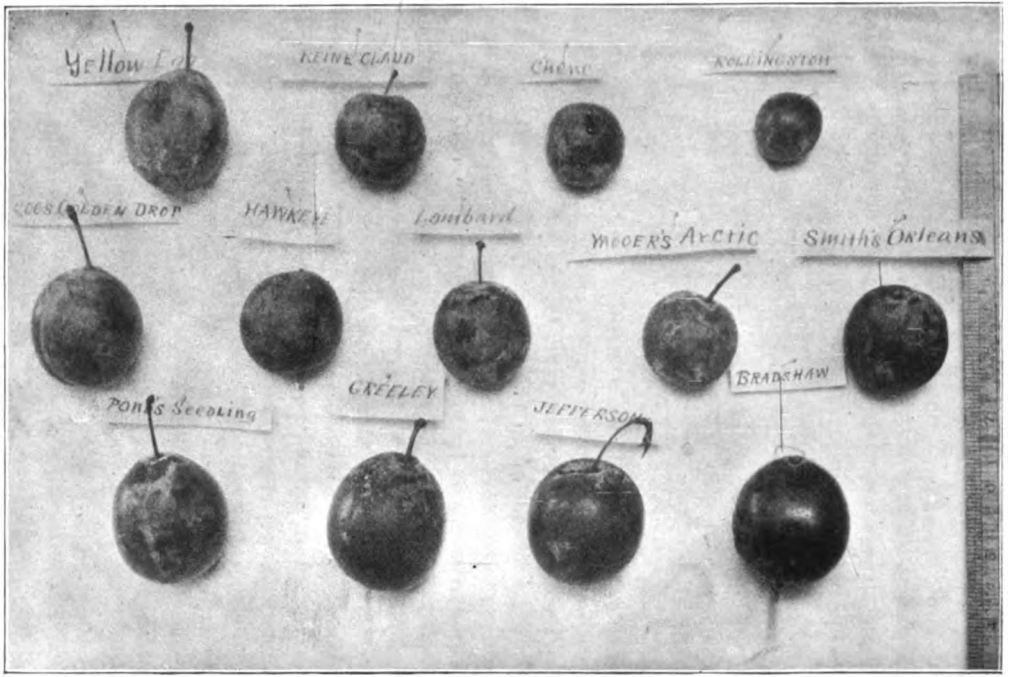


FIG. 7.—Plums from central part of New Hampshire.

Digitized by Google

struggle for existence, were loaded. Mr. A. M. Cluff of Greenland set 2,133 Fay currant bushes the past season. Gooseberries were very scarce and we have yet to know of any in the state. At the prices asked in Dover, 12½ cents, they could be made a very profitable crop. Cranberries were exhibited at the fairs, most of which were very fine. The Station desires information from those attempting cranberry culture.

F. Wm. Rane,
Agriculturist and Horticulturist.

DEPARTMENT OF ENTOMOLOGY

The entomological department of the Station has been able to accomplish much more work during the season now closing, than during any previous year. This has been largely due to the appointment of an assistant, Mr. W. F. Fiske, so that it has been possible to make continuous observations upon the life-histories of injurious insects—a condition necessary to any adequate success in entomological investigations. Studies of a considerable number of insects have been made, although the major part of the assistant's time has been spent in increasing and arranging the insect collections which form, perhaps, the most essential portion of the equipment of the department. The number of insects in the collection has been doubled during the year, more than 5,000 specimens having been added. The card index to entomological literature has also been much increased, and the general facilities for the carrying on of the work have been improved.

Digitized by Google

The insectary has been found useful in studying the life-histories of insects, and its utility is likely to increase as the scope of the work undertaken enlarges.

Fig. 1. Rose leaf eaten by Tent Caterpillars. (Original.)

I desire here to express my thanks to Dr. L. O. Howard and the entomologists associated with him in the Entomological Division of the United States Department of Agriculture, for the determination of many insects during the year. The assistance thus rendered has always been prompt and courteous, and has been of great value in our work. It deserves the fuller acknowledgment, because it is seldom practicable to render adequate return for the favors so freely given.

The Insect Record for 1897

The ravages of the common Tent Caterpillar continued during the early part of the season to very much the same extent as last year. We followed the history of the insects, carefully noting their range of food-plants and times of transformations, and began a systematic study of the natural enemies of the pest. We hope to continue this investigation through the coming season. Already we have bred more than twenty different species of primary and secondary parisites from these tent caterpillars, which fortunately are subject to such enemies from the time they are in the egg until they become full grown. These studies have served again to show how intricate are the

Digitized by Google

arrangements by which the increase and decrease of noxious insects are regulated.

The extending range of food-plants mentioned in my previous reports upon the tent caterpillar was as much in evidence this season as before. Mr. Fiske, who was instructed to make special observations upon this phase of the subject, has summarized his notes as follows: The list of food-plants of the American tent caterpillar is long and varied, and when compared with other caterpillars, a peculiar fact is noticeable. In most cases where the food is varied, the insects confine themselves to certain orders of plants, usually nearly related to each other, but the prime requisite with the present species seems to be that the plants shall be of a shrubby nature. The members of the rose family seem to be the natural food of the tent caterpillar, and very few, if any, of the shrubby and arboreal members of this family escaped. All species of plum, pear, and apple (the genera *Prunus* and *Pyrus*) seem to be used for the deposition of eggs, although the two common wild cherries, the black cherry and the choke cherry, and the apple are most commonly chosen. The egg-masses are seldom deposited upon roses, although the caterpillars attack the leaves readily (Fig. 1). The herbaceous members of the family are, however, let severely alone, and even the shrubby dewberries, raspberries, and blackberries (of the genus *Rubus*) are seldom touched. The woody spiraeas or hardhacks are fed upon, especially the white hardhack. Outside the rose family I have seen original colonies (that is, colonies from egg-masses deposited on the plant), on species of but few families. Perhaps

Fig. 2. Poplar leaf eaten by Tent Caterpillars (Original.)

Digitized by Google

the most common of these belong to the willow family, the leaves of all species of willow and poplar (Fig. 2) being eagerly devoured. Original colonies are also frequently found upon species of the oak family, the birch being, in fact, one of the more common food-plants, while the oak (Fig. 3), hazel, and alder form no slight item in the bill of fare. The only other orders on which original colonies were found were the barberry and dogwood families. Colonies with egg-masses occurred commonly on barberry bushes, and a single tent with the egg-mass was once found on a species of Cornell.

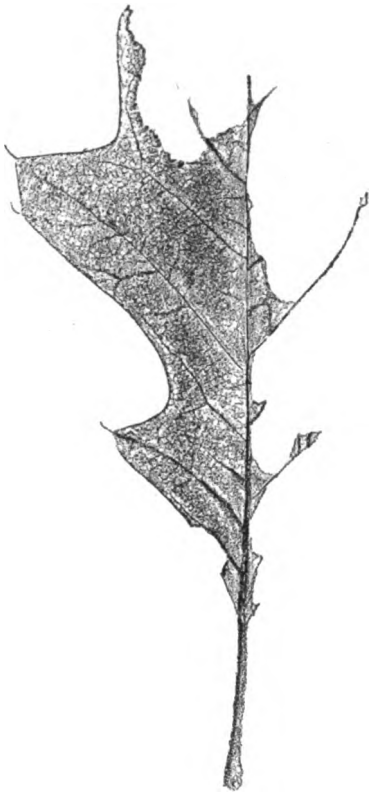


Fig. 3. Oak leaf eaten by Tent Caterpillars. (Original.)

The secondary food-plants were much more varied; it did not seem to make so much difference what they were so long as they were of a woody nature. Maple, locust, currant, witch hazel, viburnum, and blueberry are all attacked, and each belongs to a different family. The only case of an herbaceous diet found was that of a caterpillar in the midst of a field, feeding on the common ox-eye daisy.

The parasites of the tent caterpillar, as already indicated, include many species. The four-winged flies of the genus *Pimpla*—one of the many groups of ichneumon flies—are among the most important of these. The several stages of life of a *Pimpla* parasite are shown in Fig. 4, which was drawn under the writer's direction, when he was connected with the Ohio Experiment Station, and is here used by courtesy of the

Digitized by Google

officers of that station. The egg is shown at *a*; the larva at *b*; the pupa at *c*; and the adult at *d*. These figures were made from the parasite as it preys upon the larva of a borer in

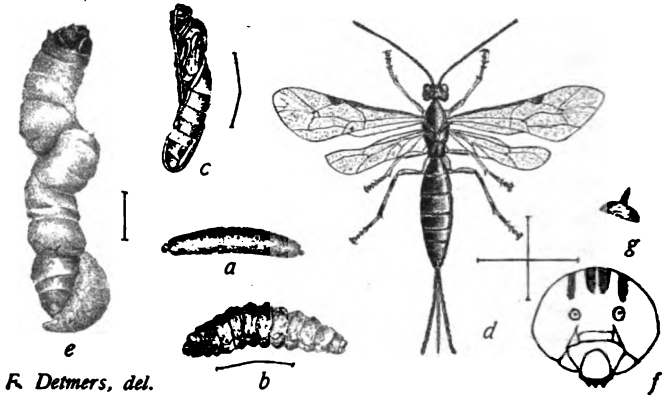


Fig. 4. Life stages of a Pimpla Parasite. (By the courtesy of the Ohio Experiment Station.)

the stems of the evening primrose[1] in which case the parasitic grub feeds externally on its host as shown at *e*. The most abundant species of *Pimpla*,[2] however, as a parasite of the tent caterpillar lives inside the host, which generally is not killed until after it has spun its cocoon.

In addition to the very general attack of the common tent caterpillar, there have been in many parts of the state more dangerous outbreaks of the FOREST TENT CATERPILLAR.[3] This

Fig. 5. Moths of Forest Tent Caterpillar: *a*, Male; *b*, Female. Natural size. (Original.)

insect has been known for many years to become destructive at intervals to a great variety of trees. Its outbreaks are more periodic than those of the common species, and, while they

[1] *Oenothera biennis.* [2] *Pimpla conquisitor.* [3] *Clisiosampa disstria.*

Digitized by Google

last, generally result in much greater damage. The life-history of both species is quite similar, the chief difference being that the eggs of the forest caterpillars have no protective covering, and that for most of their lives these make no protecting tent, feeding in colonies, however, and crowding together when not eating. Spraying with Paris green when the caterpillars are young is, perhaps, the best general remedy, although, of course, this is impracticable in many cases on forest lands.

There is generally a noticeable difference between the cocoons of the forest tent caterpillars and the common species, the first named having a great deal of loose silk around the outside of the cocoon when it is not spun within the shelter of a leaf. It seems, however, that a leaf is generally used as the outer covering when the insects are numerous on forest trees. A maple grove of several acres at Jefferson, New Hampshire, was stripped of its foliage by these caterpillars, the cocoons being made by sewing the leaves together as represented in Fig. 6. The specimen from which the drawing was made was sent me through the courtesy of Mr. Samuel D. Davis. This forest tent caterpillar has seldom been destructive in New Hampshire heretofore. We are trying to learn its full life-history and hope to issue a bulletin concerning it next season.

Fig. 6. Cocoon of Forest Tent Caterpillar. Natural Size. (Original.)

The Canker Worm, which was discussed at some length in Bulletin 44, issued by this station last April, has continued to do damage to orchards in certain localities, but in regions where the pests were destroyed by spraying in 1895 or 1896 the outbreak appears to have been satisfactorily checked. Specimens of the fall canker worm moth[1] were sent to me from Hanover, November 3, 1897, with the statement that they had "been very common for the last few days, flying into the halls in the evening, apparently attracted by the electric lights."

[1] *Anisopteryx pometaria.*

Digitized by Google

This indicates that the pest is again on the increase there, so that it will be well to protect the noble elms which add so much to the charm of this beautiful village.

The small crop of apples, as was to be expected, was seriously damaged by the APPLE WORMS—the young of the Codling Moth. It is in place here to mention the recent observations of several entomologists—notably Messrs. Washburn of Oregon, Slingerland of New York, and Card of Nebraska—showing that the eggs of this insect are frequently laid upon the *leaves* of apple trees, instead of wholly upon the fruit as heretofore supposed. From an economic point of view this renders more evident the advantage of spraying with Paris green or London purple, so commonly practised by commercial orchardists.

Our observations in many parts of the state, as well as reports from correspondents, show that the OYSTER-SHELL BARK-LOUSE continues to do serious damage in young apple orchards. Its depredations are the more to be feared because the presence of the pest is so frequently overlooked. The scales are the color of the bark, to which they closely adhere so that unless attention is called to them, they are likely to escape notice until they become excessively numerous. Young orchards should be frequently examined; if on the bark of the trunk, branches, or twigs, brown scales the shape of miniature oyster shells are seen, you may be pretty sure that the trees are infested with the oyster-shell bark-louse.

If one of these scales be removed and its lower surface looked at through a lens, a number of small, whitish, oval eggs will be found. These hatch early in summer into tiny insects that wander over the bark and foliage for a few days. They may be seen in June as microscopic whitish specks upon the trees. When thus newly hatched they are easily destroyed by spraying the trees with dilute kerosene emulsion.

I have seen no indication as yet that the dreaded San José Scale, which is causing so much consternation among fruit growers to the south and west of us, has obtained a foothold in New Hampshire. There are reasons for hoping that this pest will not thrive so far north as we are, but it seems advisable that those who plant young trees or shrubs from nurseries out-

Digitized by Google

side the state should look them over carefully for the small, round scales bordered with a reddish ring. In case such are found, it would be a favor to all concerned to send specimens to the Experiment Station for examination.

Fig. 7. Squash Bug: stage before adult. Natural size. (Original.)

Among the garden insects the SQUASH BUG[1] has continued to be a troublesome pest. The adult bugs are ready for the tender plants as soon as they appear above ground, inserting their beaks and soon destroying the plant. We have studied the pest both out of doors and in the insectary, but as yet can suggest no better remedy than that of placing shingles or pieces of boards beside the hills; the bugs will congregate under these and by a daily inspection early in the morning, they are readily found and destroyed. By thus killing off the brood that has passed the winter, much of the later damage commonly done by the progeny of these bugs will be prevented. It is well known that the brown eggs are deposited upon the under surfaces of the squash leaves, and that the young which hatch from these soon cause the death of much of the foliage. Consequently it is important to destroy as many of the egg-laying brood as possible.

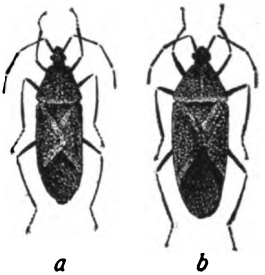


Fig. 8. Squash Bug: *a*, male; *b*, female. Natural size. (Original.)

During recent years much damage to the timber interests of the state has been done by insects. Perhaps the most notable injury has been that to spruce forests by certain small bark-boring beetles. This subject has been studied by us to a considerable extent during the season, and we hope to continue the investigation during next year. We also have begun a systematic study of the bumble bees of the state in the hope of rendering the setting of clover seed, as well as squashes and pumpkins, more certain.

CLARENCE M. WEED,
Entomologist.

[1] *Anasa tristis.*

Digitized by Google

DEPARTMENT OF BACTERIOLOGY

The details and results of experiments in treatment of plant diseases during the season of 1896 have been published in Bulletin No. 45.

The following experiments have been carried on during the time covered by this report. It being the non-bearing year the experiments in the treatment of the diseases of the apple in 1897 were limited, being directed to the disease of the foliage known as *Phyllosticta pirini* or leaf spot. As in previous years the Bordeaux mixture has seemed to have but little effect on this disease. During the last three years the apple scab has done comparatively little damage either to the foliage or fruit.

Quince trees were sprayed for the prevention of fungous diseases. Orange rust, which is very common in this vicinity, seems to be but little affected by the treatment. Black rot was so trifling in amount, on even the unsprayed trees, that no conclusions could be drawn. A disease of the foliage, whose identity has not been determined, was largely prevented by the spraying.

Experiments in spraying with Bordeaux mixture against black knot were begun. As the station plum orchard is small and the trees young, they were all sprayed during the time when infection by the summer spores was likely to take place. For the purpose of comparing the development of knots on sprayed and unsprayed trees, a hedge row of choke cherries was made the subject of the experiment. The result of the treatment will not be apparent until spring, when the new knots make their first appearance.

A substance known as Ceres-pulver was sent to the station for trial as a preventative of smut in oats and barley. It is to be applied by soaking the seed in a solution of it. In our trials there was little smut in any of the grain, but rather less where the seed was treated with Ceres-pulver.

Experiments on potato scab were continued on the following lines: effect of different fertilizers, stable manure, phosphate, ashes, lime, kainit, on the development of the disease, effect of treatment with corrosive sublimate, formaline, and sulphur as

Digitized by Google

preventatives. Experiments in the treatment of the early and late blights of potatoes were continued.

Experiments in dairy bacteriology were carried on as time would permit.

The plants belonging to the natural order Leguminosæ or the pulse family, such as peas, beans, clover, etc., have on their roots little structures known as root tubercles, which are caused by and contain bacteria-like organisms which are believed to enable the plant in some way to make use of atmospheric nitrogen as food. Cultures of these organisms are now on the market to be used for the inoculation of soil on which any of the legumes are to be grown with the purpose of increasing the number of root tubercles and consequently the assimilation of nitrogen.

A culture, called *Nitragin*, of the organism to be used for peas was sent to the station for trial. This was tried together with crushed tubercles from growing peas. The result in one case seemed to be in favor of the treated plots, and especially that treated with the crushed pea tubercles. The culture was, however, so old when used, and the trial on so small a scale that farther trial is necessary before results can be considered of value. The subject seems to be an interesting and profitable one for investigation.

Caustic potash as a means of preventing the development of the horns of calves has been used with success. The details of the experiments will be published in a forthcoming bulletin on dehorning.

H. H. LAMSON,
Bacteriologist.

Digitized by Google

DEPARTMENT OF METEOROLOGY AND AGRICULTURAL ENGINEERING, 1896–'97

I. Meteorology

Observations have been continued the past year as heretofore under the charge of James A. Foord, New Hampshire College, class of '98. During July and August of 1896 the work was performed by Arthur Given, also of the class of '98.

Signal flags have been displayed each day, from 11 a. m. till sunset, indicative of the weather for the following day.

The weather for the year has been characterized by an excessive precipitation; nearly ten inches above the normal. No single month has shown a marked deficiency; the least number of rainy days reported in any one being five, as compared with two the year previous. We seem to be passing through a series of years with large and well distributed rainfall, possibly culminating the past year. The ground has kept well filled with water, springs have yielded abundantly, and the surface has rarely lacked moisture.

The snow fall for the year was small; about the same as the previous winter, and much less than the normal. No snow of any account fell till January 21, and the total for March was small, thus cutting off the supply at both ends. The heavy rainfall of January, February, and March was accompanied, as was to be expected, by a higher average temperature than for either the preceding year or any normal one. A small precipitation kept the temperature of December down to a lower point than in 1895, it being almost as cold on the average as January, which was naturally the coldest of the year.

Specially high water and floods were occasioned by the excessive rainfalls of September 6, 1896, and June 10, 1897. In the latter case $6\frac{3}{4}$ inches fell within twenty-four hours and most of this within twelve hours.

The summer months of 1896 were on the whole quite normal. Only one sustained heated spell occurred in July and

Digitized by Google

one in August. The former was of average duration and intensity; the latter of average duration but of exceptional severity.

Frosts held off remarkably in the fall. The first to do serious damage occurred September 24th, while the first absolutely killing one was delayed until October 10th.

The detailed record of observations taken, together with a summary of the same, will be found appended in the special edition of this bulletin, which may be obtained upon application.

II. Agricultural Engineering

During the year this department has made surveys for drainage purposes over a small portion of the black swamp field, and for straightening brooks at three different points on the college farm.

Much labor has been involved in the problem of establishing proper bounds for the highway in front of college property. Such bounds have been located and marked by permanent stone posts on both sides of the turnpike from the top of Spinney hill to the corner east of the president's house, leaving a full width of four rods for the highway the whole distance. These bounds have been assented to by the selectmen, and full records with map have been placed upon the town books. The work of establishing other bounds has been partly done and the same will be prosecuted as time allows.

During the year the steam drill, which had been previously loaned to the institution, has been purchased at a very satisfactory price and added to the college road equipment. It was used in July of 1897, to assist the highway agents of Durham in cutting down the grade of a public way, and proved its utility beyond question. Bulletin 46 has been issued, giving a full account of the work of the preceding year with the steam drill, and also treating of methods of road maintenance in Durham and elsewhere.

Popular talks on road construction and maintenance have been given on numerous occasions during the year.

C. H. Pettee,
Meteorologist.

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

July, 1896.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	76.	30.14	88.	30.16	72.	80.	76.	88.	57.	72.5	31.
2	81.	30.17	85.	30.05	77.	77.	77.	98.	61.	77.	32.
3	83.	30.11	72.	30.18	78.	60.	69.	79.	60.	69.5	19.
4	66.	30.11	68.	29.96	58.5	56.	57.25	60.	56.	58.	4.
5	65.	29.78	69.	29.88	55.	58.	56.50	73.	53.	63.	20.
6	66.	30.02	67.	30.07	60.	59.	59.50	63.	53.	58.	10.
7	65.	29.94	71.	29 87	58.	59.	58.50	66.	53.	59.5	13.
8	69.	29.98	76.	30.16	63.	72.	67.50	79.	55.	67.	24.
9	74.	30.24	80.	30.24	72.5	74.5	73.50	87.	61.	74.	26.
10	89.	30.23	85.	30.14	80.	78.	79.	90.	70.	80.	20.
11	88.	30.04	80.	29.98	76.	75.	75.50	89.	61.5	75.25	27.5
12	82.	30.00	87.	29.87	78.	81.5	79.75	92.	62.	77.	30.
13	83.	29.87	83.	29.82	79.	73.5	76.25	92.	65.	78.5	27.
14	81.5	29.87	80.	29.89	75.	66.	70.50	83.	65.	74.	18.
15	74.	29.77	79.	29.57	65.5	72.	68.75	83.	60.	71.5	23.
16	71.5	29.69	78.	29.83	62.	67.5	64.75	76.5	61.	68.75	15.5
17	73.5	30.01	75.	30.18	65.	69.	67.	77.	50.5	63.75	27.5
18	75.5	30.35	76.5	30.38	71.	64.5	67.75	78.5	50.5	64.5	28.
19	74.	30.37	73.	30.27	68.	64.	66.	74.	58.	61.5	26.
20	72.5	30.17	74.5	29.94	67.	70.	68.50	78.	60.	69.	18.
21	76.	29.91	84.	30.00	74.5	76.5	75.50	88.	70.	79.	18.
22	82.	30.04	83.	29.83	77.	73.	75.	88.	65.5	76.75	22.5
23	81.	29.56	79.	29.96	75.5	65.5	70.50	78.	65.5	72.75	12.5
24	72.	29.99	72.	29.88	66.	62.	64.	75.	50.5	62.75	24.5
25	67.	29.99	75.	29.99	57.	67.	62.	77.	56.	66.5	21.
26	75.	30.51	80.	29.98	69.	73.	71.	85.	57.	71.	28.
27	74.	29.95	78.	29.79	67.	78.	72.50	79.	57.	68.	22.
28	79.	29.92	82.	30.01	75.	74.	74.50	88.5	65.	76.75	23.5
29	79.	30.04	82.	29.97	75.	72.5	73.75	81.5	61.	71.25	20.5
30	76.	29.82	77.	29.81	69.	66.5	67.75	82.	66.5	74.25	15.5
31	77.	29.85	75.	30.34	69.	64	66.50	74.5	64.	69.5	10 5
Sum ...	.....	.....	.....	.....	2154.5	2148.5	2151.5	2507.5	1850.5	2170.75	
Mean ..	.....	.....	.....	.....	69.5	69.3+	69.4+	80.8+	59.69+	70.02+	

Digitized by Google

METEOROLOGICAL RECORD

LAT. 43° 8′ N. LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL.

July, 1896.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	.....	.....	.....	.....	W.	Clear.	Maximum temperature, 93; date 2d.
2	.....	.....	.....	.....	S. W.	Clear.	
3	.....	.....	.....	.....	S. E.	Clear.	Minimum temperature, 50.5; date, 17th, 18th, 24th.
4	4 p. m.	.....	.....	.....	S.	Cloudy.	
5	.....	9 a. m.	.24	.....	S. E.	Cloudy.	
6	.....	.....	.03	.....	S. E.	Cloudy.	Mean temperature (mean max. + mean min. + 2), 69.6.
7	3.15 p. m.	8 p. m.	.32	.....	S. E.	Cloudy.	
8	.....	.....	.....	.....	W.	Partly cloudy.	
9	.....	.....	.....	.....	S.	Partly cloudy.	
10	.....	.....	.....	.....	S. W.	Clear.	Mean temperature (8 + 8 + 2), 69.5.
11	.....	.....	.....	.....	W.	Clear.	
12	.....	.....	.....	.....	S. W.	Clear.	Greatest precipitation in any 24 consecutive hours, .77; date, 15th.
13	.....	.....	.....	.....	W.	Partly cloudy.	
14	10.20 p.m.	.....	.....	.....	S. E.	Partly cloudy.	
15	7 a. m.	8.30 a. m.	.50	.....	N. W.	Partly cloudy.	
	4.30 p. m.	5.30 p. m.	.27	.....			
16	.....	.....	.....	.....	S.	Clear.	No. of clear days, 16; partly cloudy, 10; cloudy, 5; on which .01 or more precipitation fell, 11.
17	.....	.....	.....	.....	S. E.	Clear.	
18	.....	.....	.....	.....	S. E.	Clear.	
19	.....	.....	.....	.....	S. E.	Clear.	
20	4.30 a. m.	3 p. m.	.53	.....	S.	Cloudy.	
21	12 p. m.	.....	.....	.....	S. E.	Clear.	
22	.....	1 a. m.	.06	.....	W.	Partly cloudy.	Prevailing wind direction, S. E.
23	.....	.....	.....	.....	W.	Clear.	
24	10 p. m.	.....	.....	.....	S. W.	Partly cloudy.	July 15, violen thunder shower.
25	.....	8.30 a. m.	.71	.....	N. W.	Partly cloudy.	
26	.....	.....	.....	.....	S. W.	Clear.	
27	8 a. m.	10.30 a. m.	.07	.....	S. W.	Partly cloudy.	
28	10 p. m.	.....	.02	.....	S.	Clear.	
29	.....	.....	.....	.....	S.	Clear.	
30	4 a. m.	8 a. m.	.06	.....	S. E.	Partly cloudy.	
31	.....	.....	.....	.....	N. W.	Clear.	
Sum ...	.....	.....	2.85				

Digitized by Google

METEOROLOGICAL RECORD.

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

August, 1896.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	72.	30.16	74.	29.98	65.	64.5	64.75	78.	46.	62.	32.
2	67.	29.76	72.	29.84	60.	62.	61.	70.	57.5	63.75	12.5
3	73.	29.97	76.	29.96	70.5	67.5	69.	83.	54.	68.5	29.
4	77.	29.92	85.	29.90	74.	78.5	76.25	90.	59.	74.5	31.
5	78.	30.	72.	30.05	74.	62.	68.	77.	61.	69.	16.
6	70.	30.12	71.	30.04	61.5	83.5	72.50	86.	59.5	62.75	6.5
7	70.	29.99	82.	29.94	65.5	81.5	73.50	89.	63.	76.	26.
8	71.5	29.97	81.	29.97	73.	72.	72.50	86.5	65.	75.75	21.5
9	77.	29.93	81.	29.86	72.5	80.	76.25	92.5	60.	76.25	32.5
10	84.	29.94	86.5	29.89	82.	75.5	78.75	94.5	70.5	82.50	24.
11	83.	29.97	86.5	29.98	82.	77.5	79.75	95.	69.	82.	26.
12	83.	29.98	86.	30.	81.5	78.5	80.	94.5	69.	81.75	25.5
13	82.5	30.04	83.	30.06	71.5	71.	71.25	87.	71.	79.	16.
14	75.5	30.07	72.	30.08	69.5	66.	67.75	71.	65.5	68.25	5.5
15	72.5	30.15	73.	30.17	66.	68.5	67.25	73.	63.	68.	10.
16	71.5	30.05	72.	30.03	67.	70.	68.50	78.	63.	70.5	15.
17	74.	29.87	72.	29.93	72.	59.5	65.75	76.	59.5	67.75	16.5
18	69.	29.95	67.	29.93	64.5	58.	61.25	77.	48.	62.50	24.
19	64.	30.02	65.	30.13	60.	63.	61.50	69.5	45.	57.25	24.5
20	63.	30.18	72.	30.17	61.	60.	60 50	75.	46.5	60.75	28.5
21	66.	30.09	70.	30.04	63.5	62.5	63.	76.	46.	61.	30.
22	67.5	29.98	72.	30.03	61.	64.	62.5	75.5	59.	67.25	16.5
23	70.	29.96	69.5	29.89	66.	67.5	66.75	67.5	60.	63.75	7.5
24	71.	29.91	75.	29.98	68.5	67.5	68.	79.5	66.5	73.	13.
25	72.	30.06	71.5	30.11	67.	60.5	63.75	77.	57.	67.	20.
26	66.	30.16	69.	30.10	56.	62.5	59.25	73.5	53.	63.25	20.5
27	69.	30.01	69.	30.07	66.	62.	64.	68.5	55.	61.75	13.5
28	66.	30.19	68.	30.25	61.	57.	59.	73.	45.	59.	28.
29	64.	30.29	66.	30.14	59.	56.5	57.75	68.	43.	55.5	25.
30	67.	29.98	70.	29.83	65.	60.	62.50	76.	44.	60.	32.
31	67.	29.73	65.	29.83	61.	58.	59.5	67.5	49.5	58 5	18.
Sum ...	.....	.....	.....	.....	2087.	2077.	2082.	2444.5	1773.	2098.75	
Mean ..	.....	.....	.....	.....	67.3+	67.	67.1+	78.9+	57.1+	67.8+	

Digitized by Google

METEOROLOGICAL RECORD

LAT. 43° 8′ N. LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL.

August, 1896.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	11 p. m.	.....	.....	.....	S. W.	Clear.	Maximum temperature, 95; date, 11th.
2	.....	12 m.	1.32	.....	N. E.	Partly cloudy.	
3	.....	.....	.....	.....	S. E.	Clear.	Minimum temperature, 43; date, 29th.
4	.....	.....	.....	.....	N.	Partly cloudy.	
5	2.15 p. m.	3.30 p. m.	.13	.....	N. W.	Cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 67.6.
	7 p. m.	10 p. m.	.16	.....			
6	6.30 p. m.	.....	.....	.....	S. E.	Cloudy.	
7	.....	9 a. m.	.53	.....	S. W.	Partly cloudy.	
8	.....	.....	.....	.....	S. E.	Clear.	Mean temperature (8 + 8 + 2), 67.1.
9	.....	.....	.....	.....	S. W.	Clear.	
10	3.15 p. m.	3.45 p. m.	.22	.....	S. W.	Clear.	Greatest precipitation in any 24 consecutive hours, 1.32; date, 1st and 2d.
11	.....	.....	.....	.....	S.	Clear.	
12	.....	.....	.....	.....	S. E.	Clear.	
13	.....	.....	.....	.....	S. E.	Clear.	
14	5 a. m.	5.30 p. m.	.17	.....	E.	Cloudy.	
15	.....	.....	.....	.....	S.	Partly cloudy.	No. of clear days, 18; partly cloudy, 7; cloudy, 6; on which .01 or more precipitation fell, 9.
16	.....	.....	.....	.....	S. W.	Clear.	
17	.....	.....	.....	.....	N. W.	Clear.	
18	3 p. m.	7 p. m.	.01	.....	S. W.	Partly cloudy.	
19	.....	.....	.....	.....	W.	Partly cloudy.	
20	.....	.....	.....	.....	W.	Clear.	
21	.....	.....	.....	.....	S.	Clear.	Prevailing wind direction, S. E.
22	5.30 a. m.	8 a. m.	.....	.....	S. E.	Partly cloudy.	
23	11.30 a. m.	2 p. m.	.....	.....	S. E.	Cloudy.	Aug. 10, short thunder storm.
	9.30 p. m.	.....	.....	.....			
24	.....	7 a. m.	.81	.....	N. W.	Clear.	
25	.....	.....	.....	.....	S. E.	Clear.	
26	.....	.....	.....	.....	S. E.	Clear.	
27	8 a. m.	11 a. m.	.12	.....	W.	Cloudy.	
28	.....	.....	.....	.....	S. E.	Clear.	
29	.....	.....	.....	.....	S.	Clear.	
30	.....	.....	.....	.....	S.	Clear.	
31	12 m.	5 p. m.	.21	.....	W.	Cloudy.	
Sum ...	.....	.....	3.68				

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

September, 1896.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	63.	29.99	68.	30.18	56.5	53.	54.75	66.	46.5	56.25	19.5
2	59.	30.30	63.	30.16	59.	57.5	58.25	69.	43.	56.	26.
3	63.	29.94	71.	29.74	61.	64.5	62.75	77.	55.	66.	22.
4	66.	30.51	65.	30.14	57.	53.	55.	66.	51.	58.50	15.
5	61.	30.23	63.	30.13	54.	57.5	55.75	61.5	41.	51.25	20.5
6	61.	29.85	65.	29.78	56.	66.5	61.25	69.	52.	60.50	17.
7	64.	29.94	70.	30.08	60.	60.	60.	65.	72.	49.	60.5	23.
8	65.	30.19	67.	30.17	58.	60.	59.	70.	50.	60.	20.
9	62.	30.08	67.	29.91	59.	60.	59.5	67.	52.	59.5	15.
10	64.	29.78	66.	29.77	62.	65.	63.5	65.	59.	62.	6.
11	69.	29.92	79.	30.05	70.5	74.	72.25	88.5	62.5	75.5	26.
12	71.	30.14	77.	30.17	73.	67.	70.	84.	65.5	74.75	18.5
13	69.	30.28	65.	30.29	58.	55.	56.5	59.5	54.	56.75	5.5
14	61.	30.17	65.	29 99	55.5	57.5	56.5	62.5	53.5	58.	9.
15	63.	29.87	68.	29.90	60.	62.5	61.25	74.	56.	65.	18.
16	63.5	29.96	65.	29.90	56.5	54.	55.75	66.	53.	59.5	13.
17	62.	29.82	70.	29.67	54.5	60.	57.25	63.	52.	57.5	11.
18	67.	29.79	70.	29.96	60.	59.5	59.75	70.5	56.5	63.75	14.
19	64.	29.80	70.	29.47	55.	62.5	58.75	65.	53.	59.	12.
20	65.	29.80	66.	29.99	56.5	50.	53.25	63.	50.	56.5	13.
21	60.	29.98	65.	29.86	47.5	56.	51.75	67.	39.	53.	28.
22	61.	29.76	64.	29.77	54.	52.	53.	58.	51.	54.5	7.
23	67.	30.04	65.	30.07	44.	43.	43.50	54.5	37.5	46.	17.
24	61.	30.09	63.	30.20	43.	52.5	47.75	56.	32.5	44.25	23.5
25	57.	30.34	70.	30.34	48.5	55.	51.75	60.5	37.5	49.	23.
26	64.	30.29	73.	30 23	59.	63.	61.	76.5	52.	64.25	24.5
27	62.	30.17	75.	30.09	61.5	65.	63.25	76.	53.	64.5	23.
28	68.	30.16	73.	30.24	59	50.5	54.75	61.	50.5	55.75	10.5
29	63.	30.27	74.	30.16	46.5	55.5	51.	62.	35.	48.5	27.
30	67.	29.74	79.	29.70	63.	61.	62.	81.	54.5	67.75	26.5
Sum					1708.	1752.	1730.75	2031.	1497.	1764.25	
Mean					56.9+	58.4	57.6+	67.7	49.9	58.8+	

Digitized by Google

METEOROLOGICAL RECORD

LAT. 43° 8′ N. LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL.

September, 1896.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	.....	.....	.....	.....	N. W.	Clear.	Maximum temperature, 88.5; date, 11th.
2	.....	.....	.....	.....	S. W.	Partly cloudy.	
3	6.30 p. m.	.....	.57	.....	S. W.	Cloudy.	
4	.....	.....	.....	.....	W.	Clear.	Minimum temperature, 32.5; date, 24th.
5	10 p. m.	.....	.....	.....	W.	Cloudy.	
6	.....	During night.	3.65 2.10	.....	S.	Cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 58.8.
7	.....	.....	.....	.....	W.	Clear.	
8	.....	.....	.....	.....	S.	Clear.	
9	5 p. m.	.....	.....	.....	N. E.	Cloudy.	
10	.....	6 p. m.	.74 .41	.....	N. E.	Cloudy.	Mean temperature (8 + 8 ÷ 2), 57.6.
11	.....	.....	.....	.....	S. W.	Clear.	
12	.....	.....	.....	.....	S. E.	Clear.	Greatest precipitation in any 24 consecutive hours, 5.75; date, 5th and 6th.
13	Before daybreak.	During night.	.07	.....	N. E.	Cloudy.	
14	.....	.....	.....	.....	W.	Clear.	
15	.....	.....	.....	.....	N. W.	Clear.	No. of clear days, 15; partly cloudy, 4; cloudy, 11; on which .01 or more precipitation fell, 11.
16	.....	.....	.....	.....	W.	Clear.	
17	Light showers.	.....	.07	.....	N. E.	Cloudy.	
18	.....	During night.	.34	.....	W.	Clear.	
19	.....	During night.	.50	.....	N. W.	Cloudy.	Prevailing wind direction, W.
20	.....	.....	.....	.....	W.	Clear.	Frost, 24th, medium heavy.
21	.....	.....	.....	.....	W.	Clear.	
22	8.30 a. m.	4 p. m.	.30	.....	W.	Cloudy.	Thunderstorm beginning at 6.30 p. m. on 3d.
23	.....	.....	.....	.....	.....	Clear.	
24	.....	.....	.....	.....	N. W.	Cloudy.	
25	.....	.....	.....	.....	S.	Cloudy.	Thunderstorm at noon on 6th.
26	.....	.....	.....	.....	S. W.	Clear.	
27	.....	.....	.....	.....	S.	Clear.	
28	.....	.....	.....	.....	S.	Partly cloudy.	
29	During night.	.....	.....	.....	S. E.	Partly cloudy.	
30	.....	10 a. m.	.73	.....	S.	Partly cloudy.	
Sum ...	.....	.....	9.48				

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

October, 1896.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	68.	29.70	71.	29.82	58.	55.	56.5	68.	54.	61.	14.
2	64.	29.88	71.	30.01	54.	49.	51.5	55.	49.	52.	6.
3	60.	30.08	66.	30.13	46.	52.	49.	59.	44.	51.	15.5
4	60.	30.21	58.	30.18	50.	50.	50.	52.5	45.	48.75	7.5
5	55.	30.16	70.	30.14	46.	45.	45.5	48.5	44.5	46.5	4.
6	61.	30.06	70.	30.03	46.	47.	46.5	49.5	43.5	46.5	6.
7	59.	29.88	67.	29.84	43.5	43.	43.3	49.	39.	44.	10.
8	58.	29.94	68.	30.19	43.	42.	42.5	51.5	36.	43.75	15.5
9	57.	30.35	64.	30.46	43.	38.5	40.7	53.5	34.	43.75	19.5
10	55.	30.56	65.	30.54	40.	36.	38.	53.	29.	41.	24.
11	52.	30.47	66.	30.36	40.	46.	43.	50.5	33.	41.75	17.5
12	54.	30.20	66.	30.12	44.	50.	47.	55.	43.5	49.25	11.5
13	57.	29.88	68.	29.75	45.	46.5	45.7	49.	40.5	44.75	8.5
14	57.	29.63	70.	29.68	48.	52.	50.	53.	45.	49.	8.
15	62.	29.60	71.	29.59	45.	51.	48.	54.	43.5	48.75	10.5
16	63.	29.54	65.	29.51	44.	48.	46.	64.5	35.5	50.	29.
17	68.	29.59	64.	29.60	40.	46.5	43.3	57.	23.	40.	34.
18	63.	29.68	67.	29.88	47.5	47.5	47.5	56.	40.5	48.25	16.5
19	61.	30.00	64.	30.10	41.5	35.5	38.5	57.	33.	45.	24.
20	55.	30.12	68.	30.02	39.	52.	40.5	53.	22.5	37.75	30.5
21	60.	29.93	74.	29.82	54.	51.5	52.7	60.	49.	54.5	11.
22	60.	29.92	70.	29.99	36.	39.5	37.7	51.	31.5	41.25	19.5
23	67.	29.97	68.	29.72	32.	47.5	39.7	52.	25.	38.5	27.
24	63.	29.47	69.	29.59	47.5	43.	45.3	57.	43.	50.	14.
25	57.	29.88	49.	30.01	37.	35.5	36.3	46.	34.5	40.25	11.5
26	64.	30.16	68.	30.03	34.	44.	39.	55.5	27.	41.25	28.5
27	75.	30.13	73.	30.22	37.	46.	41.5	62.	32.	47.	30.
28	80.	30.46	70.	30.42	38.	36.5	37.3	52.	34.5	43.25	17.5
29	57.	30.29	77.	30.20	41.	49.	45.	49.5	31.5	40.50	8.
30	64.	30.00	71.	29.90	49.5	56.	52.7	59.5	45.	52.25	14.5
31	65.5	29.77	70.	29.83	51.	60.	55.5	70.	48.	59.	22.
Sum...	.....	.....	.....	.....	1350.5	1441.	1395.2	1703.0	1179.0	1440.5	.....
Mean..	.....	.....	.....	.....	43.5+	46.4+	45.0+	54.9+	38.0+	46.4+	.....

Digitized by Google

METEOROLOGICAL RECORD

LAT. 43° 8′ N. LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL.

October, 1896.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	Light shower in morning.	.....	.01	.....	W.	Partly cloudy.	Maximum temperature, 70; date, 31.
2	Showers during day.	... .	.06	.....	S. E.	Cloudy.	Minimum temperature, 22.5; date, 20.
3	.....	.....	.....	.....	W.	Cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 46.4.
4	Light showers.	.....	.01	.....	E.	Cloudy.	
5	3 p. m.	During night.	.70	.....	N. E.	Cloudy.	Mean temperature (8 + 8 ÷ 2), 44.9.
6	.....	.....	.....	.....	.....	Cloudy.	Greatest precipitation in any 24 consecutive hours, 1.72; date, 14 and 15.
7	6.45 a. m.	3 p. m.	.09	.....	S. E.	Cloudy.	
8	.....	.....	.....	.....	W.	Partly cloudy.	
9	.....	.....	.....	.....	W.	Clear.	
10	.....	.....	.....	.....	W.	Clear.	No. of clear days, 9; partly cloudy, 4; cloudy, 18; on which .01 or more precipitation fell, 13.
11	.....	.....	.....	.....	E.	Cloudy.	
12	During night.	.....	.02	.....	N.	Cloudy.	
13	11 a. m.	....	.....	.....	N. E.	Cloudy.	
14	.....	.....	1.31	.....	N. E.	Cloudy.	
15	.....	11.30 a. m.	.41	.....	N.	Cloudy.	Prevailing wind direction, W.
16	.....	.....	.....	.....	N.	Cloudy.	
17	.....	.....	.....	.....	N. E.	Cloudy.	Frost, killing, 10th.
18	5.30 p. m.	During night.	.11	.....	W.	Cloudy.	
19	.....	....	.....	.....	W.	Clear.	
20	11 p. m.	.....	.01	.....	S. W.	Cloudy.	
21	Showers.	2.30 p. m.	.19	.....	S. E.	Cloudy.	
22	During night.	.....	.....	.....	N. W.	Clear.	
23	.....	During night.	.37	.....	S. E.	Cloudy.	
24	.....	.....	.....	.....	N. W.	Partly cloudy.	
25	.....	.....	.....	.....	W.	Clear.	
26	....	.....	.....	... ..	S. W.	Clear.	
27	.....	.....	. ....	.....	N. W.	Clear.	
28	.....	.....	.....	.....	N. W.	Partly cloudy.	
29	10 a. m.	5 p. m.	.21	.....	... .	Cloudy.	
30	.....	.....	.....	.....	E.	Clear.	
31	.....	.....	.....	.....	W.	Clear.	
Sum ...	....	.....	2.50				

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

November, 1896.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	62.	29.96	60.	29.97	50.	46.	48.	64.	44.5	54.25	19.5
2	63.	30.03	67.	30.19	40.	45.	42.50	65.	34.	49.50	31.
3	66.	30.33	61.	30.37	39.5	40.	39.75	55.	39.5	47.25	15.5
4	59.	30.41	68.	30.28	41.	48.	44.50	51.5	31.5	41.50	20.
5	59.	30.04	70.	29.57	50.	59.	54.50	60.5	46.5	53.50	14.
6	71.	29.63	69.	29.76	51.5	48.	49.75	54.	46.5	50.25	7.5
7	72.	29.90	66.	29.88	43.	43.	43.	58.	38.5	48.25	19.5
8	65.	29.83	55.	29.70	40.	46.	43.	46.	34.5	40.25	11.5
9	55.	29.89	68.	30.04	35.	34.5	34.75	47.5	34.	40.75	13.5
10	60.	30.30	69.	30.36	31.5	35.	33.25	50.	28.	39.	22.
11	57.	30.16	72.	29.88	44.	55.	49.50	58.	29.	43.50	29.
12	64.	29.99	70.	29.96	43.	43.	43.	47.	41.	44.	6.
13	60.	29.91	68.	29.80	31.	33.	32.	44.	27.	35.50	17.
14	54.	29.94	65.	30.15	29.	26.5	27.75	36.5	26.	31.25	10.5
15	43.	29.93	47.	29.96	31.	44.5	37.75	50.5	23.	36.75	27.5
16	45.	30.09	62.	30.12	30.	43.	36.50	52.5	38.5	45.50	14.
17	57.	29.97	75.	30.12	46.	62.	54.	72.	35.	53.5	37.
18	62.	30.29	68.	30.01	37.5	38.	37.75	41.	37.5	39.25	3.5
19	64.	29.79	62.	30.25	56.5	32.5	44.50	60.	32.5	46.25	27.5
20	50.	30.44	55.	30.54	23.	19.5	21.25	40.	19.5	29.75	20.5
21	43.	30.47	53.	29.93	20.	29.5	24.75	32.	15.	23.50	17.
22	48.	30.11	42.	30.49	32.	25.	28.50	50.	25.	37.50	25.
23	42.	30.73	67.	30.60	16.5	31.	23.75	35.	11.	23.	24.
24	55.	30.21	68.	30.37	44.	45.	44.50	57.	30.	43.50	27.
25	60.	30.53	64.	30.53	37.	37.	57.	45.	34.	39.50	11.
26	49.	30.34	52.	30.12	30.	33.	31.50	33.	29.	31.	4.
27	50.	29.97	70.	29.98	36.5	62.	49.25	70.	32.5	51.25	37.5
28	63.	29.93	60.	30.08	62.	45.5	53.75	68.	45.	56.50	23.
29	55.	30.20	48.	30.28	36.	33.	34.50	41.5	33.	37.25	8.5
30	45.	30.27	63.	30.22	27.5	25.	26.25	33.	24.	28.50	9.
Sum...	.....	.....	.....	.....	1124.0	1207.5	1170.75	1517.5	965.0	1241.25	.....
Mean..	.....	.....	.....	.....	37.4+	40.2	39.0+	50.58½	32.16½	41.3+	.....

Digitized by Google

METEOROLOGICAL RECORD

LAT. 43° 8′ N. LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL.

November, 1896.	PRECIPITATION.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	.....	.....	.....	.....	E.	Cloudy.	Maximum temperature, 72; date, 17.
2	.....	.....	.....	.....	W.	Clear.	
3	.....	.....	.....	.....	W.	Clear.	Minimum temperature, 11; date, 23.
4	During night.	.....	1.30	.....	S. E.	Cloudy.	
5	.....	During night.	.11	.....	E.	Cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 41.3.
6	.....	.....	.....	.....	N. W.	Clear.	
7	During night.	.....	.....	.....	S. W.	Clear.	Mean temperature (7 + 8 ÷ 2), 38.8.
8	.....	6 p. m.	.18	.....	N. E.	Cloudy.	Greatest precipitation in any 24 consecutive hours, 1.41; date, 5.
9	.....	.....	.....	.....	W.	Partly cloudy.	
10	.....	.....	.....	.....	S. W.	Clear.	
11	11.30 a. m.	5 p. m.	.14	.....	S. W.	Cloudy.	
12	Showers.	.....	Trace.	.....	S. W.	Cloudy.	Depth of snow on ground at end of month, 0.8 inches.
13	2 p. m.	During night.	.07	.5	N. W.	Cloudy.	
14	.....	.....	.....	.....	N. W.	Clear.	No. of clear days, 7; partly cloudy, 9; cloudy, 14; on which .01 or more precipitation fell, 8.
15	.....	.....	.....	.....	W.	Partly cloudy.	
16	.....	.....	.....	.....	W.	Partly cloudy.	
17	.....	.....	.....	.....	S. W.	Partly cloudy.	
18	.....	.....	.....	.....	E.	Cloudy.	
19	.....	.....	.....	.....	N. W.	Partly cloudy.	
20	.....	.....	.....	.....	N. W.	Partly cloudy.	Prevailing wind direction, W. and N. W.
21	11 a. m.	8 p. m.	.62	.....	N. W.	Cloudy.	
22	.....	.....	.....	.....	W.	Clear.	
23	.....	.....	.....	.....	W.	Partly cloudy.	
24	.....	.....	.....	.....	S. W.	Partly cloudy.	
25	5 p. m.	.....	.....	.....	S. E.	Cloudy.	
26	.....	During night.	.43	.....	N. E.	Cloudy.	
27	.....	.....	.....	.....	S. E.	Partly cloudy.	
28	6 p. m.	During night.	.50	.....	E.	Cloudy.	
29	9 p. m.	During night.	.12	1.25	N. W.	Cloudy.	
30	.....	.....	.....	.....	S. W.	Cloudy.	
Sum...	.....	.....	3.47	1.75			

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

December, 1896.	8 A. M.		8 P. M.		Temperature.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	56.	30.26	59.	30.86	18.	18.5	18.25	31.	17.	24.	14.
2	50.	30.41	56.	30.86	13.5	13.	13.25	26.5	13.	19 75	13.5
3	42.	30.29	55.	30.26	6.	7.5	6.75	19.	6.	12.50	13.
4	48.	30.31	60.	30.15	8.	30.	19.	34.	5.5	19.75	28.5
5	56.	29.97	63.	30.07	30.	32.	31.	43.	29.	36.	14.
6	51.	30.06	59.	29.94	32.	42.	37.	53.	28.	40.50	25.
7	54.	29.96	63.	30.13	37.5	34.5	36.	48.	34.	41.	14.
8	54.	30.27	63.	30.10	23.	33.	28.	43.	22.	32.50	21.
9	59.	29.36	59.	29.41	38.	35.5	36.75	42.5	32.5	37.50	10.
10	59.	29.52	68.	29.75	37.	32.	34.50	44.	32.	38.	12.
11	60.	29.90	64.	30.04	32.	28.	30.	37.	26.	31.50	11.
12	57.	29.99	65.	30.91	24.	32.	28.	46.	21.	33.50	25.
13	50.	30.71	49.	29.56	30.5	35.	32.75	46.	26.5	36.25	19.5
14	53.	29.83	57.	30.08	37.	26.	31.50	42.	26.	34.	16.
15	49.	30.17	55.	30.06	15.	21.	18.50	27.	13.	20.	14.
16	37.	29.75	51.	29.75	18.	26.	22.	41.	16.	28.50	25.
17	62.	29.96	58.	30.17	21.5	25.	23.25	38.	20.	29.00	18.
18	50.	30.14	64.	29.86	16.	38.	27.	38.	10.	24.	28.
19	56.	29.63	50.	29.88	28.	15.	21.50	47.	15.	31.	32.
20	43.	29.88	45.	29.87	13.	15.	14.	25.	11.5	18.25	13.5
21	60.	29.90	68.	29.90	9.	25.	17.	27.	5.5	16.25	21.5
22	69.	29.92	64.	29.95	10.	19.	14.5	20.	6.	13.	14.
23	47.	29.89	58.	29.92	12.	15.	13.5	29.	10.5	19.75	18.5
24	53.	30.09	61.	30.23	5.	9.	7.	30.	4.	17.	26.
25	61.	30.33	41.	30.28	7.5	12.	9.75	21.	7.	14.	14.
26	41.	29.95	64.	30.15	23.	25.	24.	31.	11.5	21.25	19.5
27	61.	30.66	53.	30.82	0.	10.	5.	21.	—2.	9.5	23.
28	62.	30.80	63.	30.56	0.	21.5	10.75	32.	—3.5	14.25	35.5
29	60.	30.23	63.	30.27	22.	35.	28.50	41.5	15.	28.25	26.5
30	58.	30.28	69.	30.01	23.	35.	29.	43.	22.	32.50	21.
31	60.	30.09	63.	30.50	40.	25.	32.50	42.	25.	33.50	17.
Sum	.....	.....	.....	.....	629.5	770.5	700.5	1108.5	505.	806.75	.....
Mean	.....	.....	.....	.....	20.3+	24.8+	22.5+	35.7+	16.2+	26.0+	.....

Digitized by Google

METEOROLOGICAL RECORD

r. 43° 8′ N. Long. 70° 56′ W. Barometer 125 Feet Above Sea Level.

	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	.....	.....	.....	.....	N. W.	Clear.	Maximum temperature, 53; date, 6.
2	.....	.....	.....	.....	N. W.	Clear.	
3	.....	.....	.....	.....	N. W.	Clear.	Minimum temperature, —3.5; date, 28.
4	9 p. m.	During night.	.05	0.5	N. W.	Partly cloudy.	
5	.....	.....	.....	.....	S. W.	Partly cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 26.0.
6	.....	.....	.....	.....	W.	Cloudy.	
7	.....	.....	.....	.....	S.	Cloudy.	
8	9 p. m.	.....	.....	.....	N. E.	Cloudy.	Mean temperature (8 + 8 + 2), 22.5.
9	.....	12.30 p. m.	1.29	.....	W.	A. M. cloudy; P. M. clear.	Greatest precipitation in any 24 consecutive hours, 1.29; date, 8-9.
10	.....	.....	.....	.....	W.	Partly cloudy.	
11	.....	.....	.....	.....	N. W.	Partly cloudy.	
12	.....	.....	.....	.....	S. W.	Clear.	
13	.....	.....	.....	.....	.....	Partly cloudy.	Depth of snow on ground at end of month, traces.
14	.....	.....	.....	.....	N. W.	Partly cloudy.	
15	.....	.....	.....	.....	N.	Cloudy.	
16	9 a. m.	During night.	.3	3.	N.	Cloudy.	No. of clear days, 10; partly cloudy, 11; cloudy, 10; on which .01 or more precipitation fell, 5.
17	.....	.....	.....	.....	N.	Clear.	
18	6.30 p. m.	During night.	.12	.....	.....	Cloudy.	
19	.....	.....	.....	.....	N. W.	Clear.	
20	.....	.....	.....	.....	N. W.	Cloudy.	Prevailing wind direction, N. W.
21	.....	.....	.....	.....	S. W.	Cloudy.	
22	.....	.....	.....	.....	N. W.	Cloudy.	Snow on 16th with strong wind from the North, so that no close measurement was possible.
23	Light snow squalls.	.....	.....	Trace.	N.	Cloudy.	
24	.....	.....	.....	.....	N. W.	Partly cloudy.	
25	.....	.....	.....	.....	.....	Clear.	
26	.....	.....	.....	.....	N. W.	Partly cloudy.	
27	.....	.....	.....	.....	N. W.	Clear.	
28	.....	.....	.....	.....	N. W.	Clear.	
29	.....	.....	.....	.....	W.	Partly cloudy.	
30	.....	.....	.....	.....	N. W.	Partly cloudy.	
31	.....	.....	.....	.....	N. W.	Clear.	
...	.....	....	1.76	3.5			

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE,

January, 1897.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	53.	30.70	61.	30.48	15.	19.	17.	33.	13.	23.	20.
2	60.	30.60	68.	30.49	27.	33.5	30.25	43.	17.	30.	26.
3	55.	30.39	58.	30.29	37.	43.	40.	58.5	30.	41.75	28.5
4	54.	30.18	69.	30.00	40.	44.	42.	54.	37.	45.50	17.
5	64.	29.61	67.	29.51	50.5	41.	45.75	55.	41.	48.	14.
6	56.	29.60	60.	29.71	31.	24.	27.50	37.	24.	30.50	13.
7	53.	30.06	57.	30.33	27.5	20.	23.75	43.	20.	31.50	23.
8	45.	30.40	52.	30.28	14.	17.	15.50	32.	13.	22.50	19.
9	51.	30.17	58.	29.93	13.	20.	16.50	29.	12.	20.50	17.
10	50.	29.71	46.	29.68	24.	31.	27.50	40.	19.	29.50	21.
11	46.	29.70	59.	29.62	27.	28.	27.50	37.	26.	31.50	11.
12	50.	29.68	50.	29.92	11.	6.	8.5	27.	6.	16.50	21.
13	51.	30.18	53.	30.20	3.	13.	8.	25.	2.	13.	23.
14	45.	30.21	50.	30.22	9.5	22.5	16.	23.5	7.	15.25	16.5
15	44.	30.21	50.	30.18	22.	20.	21.	30.	18.5	19.25	11.5
16	45.	30.15	58.	30.17	22.5	28.	25.25	41.	19.	30.	22.
17	47.	30.20	44.	29.86	18.	25.	21.50	38.	16.	27.	22.
18	48.	29.33	52.	29.67	46.	18.	32.	49.	18.	33.50	31.
19	38.	30.14	42.	30.34	—6.	—2.	—4.	11.	—6.5	2.25	17.5
20	48.	30.50	49.	30.34	—2.5	18.5	8.	20.	—8.	6.	28.
21	44.	29.73	55.	29.65	32.	34.	33.	49.	17.	33.	32.
22	51.	29.56	57.	29.55	31.	30.	30.5	37.	27.	32.	10.
23	51.	29.34	53.	29.68	28.	22.	25.	32.	21.5	26.75	10.5
24	50.	29.82	42.	29.60	10.5	9.5	10.	20.	9.5	14.75	10.5
25	39.	29.58	52.	29.36	—1.5	10.	4.25	10.	—1.5	4.25	11.5
26	59.	29.36	63.	29.51	19.	25.	22.	39.	10.	24.50	29.
27	70.	29.84	61.	29.86	19.	27.	23.	31.	18.	24.50	13.
28	45.	29.38	47.	29.08	21.	23.	22.	27.	16.5	21.75	10.5
29	56.	29.58	60.	29.95	20.	22.	21.	41.	17.5	29.25	23.5
30	59.	30.27	63.	30.47	10.	19.	14.50	32.	6.	19.	26.
31	53.	30.63	58.	30.58	7.	21.	14.	36.	2.	19.	34.
Sum...	.....	.....	.....	.....	625.5	712.	672.7	1075.	467.5	765.75	.....
Mean..	.....	.....	.....	.....	20.17+	22.9+	21.7+	34.6+	15.08+	24.7+	.....

Digitized by Google

METEOROLOGICAL RECORD

r. 43° 8′ N. Long. 70° 56′ W. Barometer 125 Feet Above Sea Level.

Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
.....	.....	.....	.....	.....	Clear.	Maximum temperature, 55; date, 5th.
.....	.....	.....	.....	N. W.	Clear.	
During night.	.....	.01	.....	N. W.	Clear.	Minimum temperature,—8; date, 20th.
6 p. m.	.....	.....	.....	.....	Partly cloudy.	Mean temperature (mean max. + mean min. + 2), 24.8.
.....	5 p. m.	1.84	.....	S. E.	Cloudy.	
Snow squall.	.....	.....	Trace.	S. W.	Cloudy.	
.....	.....	.....	.....	S. W.	Clear.	Mean temperature (8 + 8 ÷ 2), 21.5.
.....	.....	.....	.....	N. W.	Clear.	
During night.	.....	.....	Trace.	N. W.	Partly cloudy.	Greatest precipitation in any 24 consecutive hours, 1.95; date, 20-21.
.....	.....	.....	.....	N. W.	Cloudy.	
1.30 p. m.	5 p. m.	.....	Trace.	N.	Cloudy.	
.....	.....	.....	.....	N. W.	Clear.	No. of clear days, 16; partly cloudy, 6; cloudy, 9; on which .01 or more precipitation fell, 9.
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Partly cloudy.	
Flurries.	.....	.....	Trace.	W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
5.30 p. m.	During night.	.17	1.	S. E.	Cloudy.	
.....	.....	.....	.....	N. W.	Partly cloudy.	Prevailing wind direction, N. W.
.....	.....	.....	.....	N. W.	Clear.	
7.30 p. m.	.....	.....	.....	N. W.	Clear.	21st, snow turned to rain about 9 a. m.
.....	4 p. m.	1.95	8.	N. E.	Cloudy.	Snow, 8 in.; rain, 1.15 in.
During night.	.....	.07	.7	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Cloudy.	
.....	.....	.....	.....	N. W.	Partly cloudy.	
.....	.....	.....	.....	N. W.	Partly cloudy.	
During night.	.....	.....	.....	N. W.	Cloudy.	
.....	During night.	.80	8.	N.	Cloudy.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	.....	Clear.	
.....	.....	4.84	17.7			

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

February, 1897.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	63.	30.45	71.	30.22	4.	23.	13.50	35.	2.	18.50	33.
2	61.	30.08	63.	29.90	9.	32.	20.50	35.	4.	19.50	31.
3	50.	29.80	48.	29.92	25.	24.	24.50	31.5	24.	27.75	7.5
4	56.	30.16	63.	30.26	17.	22.	19.50	31.	16.	23.50	15.
5	59.	30.40	69.	30.41	6.	25.	15.50	37.	5.	21.	32.
6	67.	30.35	66.	30.11	21.	38.	29.50	38.	19.	28.50	19.
7	52.	29.65	51.	29.56	41.	37.	39.	43.	34.	38.50	9.
8	61.	29.75	67.	29.75	37.	37.	37.	43.	35.	39.	8.
9	64.	29.85	62.	30.00	32.	28.	30.	37.	27.	32.	10.
10	65.	30.13	63.	30.17	26.	18.	22.	32.	18.	25.	14.
11	70.	30.25	65.	30.21	10.	13.5	11.75	25.	8.	16.50	17.
12	64.	30.07	56.	29.65	10.5	11.	10.75	19.	8.5	13.75	11.5
13	68.	29.91	55.	30.05	14.	18.5	16.25	27.	11.	19.	16.
14	60.	30.06	56.	29.78	11.	29.	20.	38.5	6.5	22.50	32.
15	53.	29.89	69.	29.82	24.	31.	27.50	37.	20.5	28.75	16.5
16	61.	29.65	65.	29.69	31.5	30.	30.75	35.	29.5	32.25	5.5
17	61.	29.94	65.	29.76	22.	36.	29.	38.	20.5	29.25	19.5
18	72.	29.68	69.	29.85	32.	36	34.	44.	29.	36.50	15.
19	76.	29.94	61.	30.14	28.5	21.5	25.	34.	21.	27.50	13.
20	78.	30.36	67.	30.19	19.	29.5	24.25	35.	15.	25.	20.
21	52.	29.74	52.	29.76	32.	40.	36.	48.	26.	37.	22.
22	56.	30.07	62.	30.04	29.	30.	29.5	32.	27.	29.50	5.
23	53.	29.46	66.	29.71	22.	27.5	24.75	35.	21.	28.	14.
24	80.	29.93	61.	30.15	26.	27.	26.50	35.	22.	28.50	13.
25	69.	30.14	69.	29.87	10.	39.	24.5	40.5	3.5	22.	37.
26	84.	30.12	63.	30.17	18.	18.	18.	28.	17.	22.50	11.
27	83.	30.42	62.	30.34	7.	22.	14.50	27.	5.5	16.25	22.5
28	48.	30.37	48.	30.48	10.	14.	12.	26.5	5.	15.75	21.5
Sum	.....	.....	.....	.....	574.5	757.5	666.0	967.0	480.5	723.75	.....
Mean	.....	.....	.....	.....	20.51	27.05	23.78	34.53	17.16	25.84	.....

Digitized by Google

METEOROLOGICAL RECORD

'. 43° 8′ N. Long. 70° 56′ W. Barometer 125 Feet Above Sea Level.

Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
.....	.....	.....	.....	.....	Clear.	Maximum temperature, 48; date, 21st.
.....	.....	.....	.....	N. E.	Clear.	
.....	.....	.....	.....	N. E.	Cloudy.	Minimum temperature, 2; date, 1st.
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	... ...	.....	.....	Clear.	Mean temperature (mean max. + mean min. + 2), 25.8.
10 p. m.	.....	.....	.....	N. E.	Cloudy.	
.....	4 p. m.	.97	.....	N. E.	Cloudy.	
.....	.....	.....	.....	N. W.	Partly cloudy.	Mean temperature (8 + 8 + 2) 23.7.
.....	.....	.....	.....	N. W.	Partly cloudy.	
... .	.....	.....	.....	N. W.	Clear.	
.....	.....	... .	.....	N. W.	Clear.	Greatest precipitation in any 24 consecutive hours, .97; date, 7th.
1 p. m.	During night.	.50	5.	N.	Cloudy.	
.....	.....	.....	.....	.....	Clear.	
3 p. m.	.....	.....	.....	S. W.	Clear.	No. of clear days, 14; partly cloudy, 6; cloudy, 8; on which .01 or more precipitation fell, 5.
Light snows.	6 p. m.	.20	2.	S. E.	Cloudy.	
.....	.....	.....	.....	S. W.	Cloudy.	
.....	.....	.....	.....	S.	Cloudy.	
.....	.....	.....	.....	N. W.	Partly cloudy.	
.....	.....	.....	.....	N. W.	Clear.	Prevailing wind direction, N. W.
During night.	.....	.17	1.75	S. W.	Clear.	
.....	.....	.....	.....	S. W.	Clear.	
8.15 p. m.	.....	.....	.....	S. W.	Cloudy.	
.....	9.30 a. m.	.47	1.75	N. E.	Partly cloudy.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	S.	Partly cloudy.	
.....	.....	.....	.....	W.	Clear.	
....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	N. W.	Partly cloudy.	
..	.....	.....	2.31	13.50		

Digitized by Google

METEOROLOGICAL RECORD.

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

March, 1897.	8 A. M.		8 P. M.		Temperature.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	64.	30.86	64.	30.43	0.	23.	11.5	27.	—6.	10.5	33.
2	60.	30.06	65.	30.29	40.	31.	35.5	47.	22.	34.5	25.
3	57.	29.95	68.	29.63	34.	45.	39.5	45.	30.	37.5	15.
4	62.	29.97	55.	30.35	26.	27.	26.5	45.	22.	33.5	23.
5	58.	30.37	64.	29.85	19.	33.	26.	33.	12.	22.5	21.
6	64.	29.89	64.	30.40	45.	27.	36.	47.	27.	37.	20.
7	57.	30.70	50.	30.64	12.	19.	15.5	27.	9.	18.	18.
8	59.	30.60	65.	30.39	19.	32.	25.5	34.	7.	20.5	27.
9	64.	30.19	64.	30 00.	33.	34.	33.5	40.	31.	35.5	9.
10	60.	29.67	65.	29.64	37.	43.	40.	49.	34.	41.5	15.
11	65.	29.90	65.	29.96	36.	41.	38.5	51.	31.	41.	20.
12	57.	29.92	61.	29.47	33.	36.	34.5	41.	25.	33.	16.
13	63.	29.74	60.	30.22	29.	24.	26.5	34.	21.	27.5	13.
14	62.	30.28	47.	29.75	17.	18.	16.5	41.	16.	28.5	25.
15	59.	30.07	65.	30.23	26.	23.	24.5	46.	10.	28.	36.
16	71.	30.42	57.	30.46	12.	13.	12.5	32.	9.	20.5	23.
17	70.	30.45	63.	30.23	12.	29.	20.5	34.	6.	20.	28.
18	65.	30.18	68.	29.96	18.	34.	26.	40.	12.	26.	28.
19	67.	29.80	71.	29.74	36.	35.	35.5	46.	33.	39.5	13.
20	63.	29.65	68.	29.72	33.	35.	34.	35.	32.	33.5	3.
21	55.	29.99	55.	29.84	34.	40.	37.	49.	32.	40.5	17.
22	62.	29.96	65.	29.82	36.	39.	37.5	49.	32.	40.5	17.
23	62.	29.78	66.	29.78	40.	40.	40.	56.	31.	43.5	25.
24	55.	29.42	57.	29.03	32.	33.	32.5	34.	32.	33.	2.
25	56.	29.01	62.	29.23	36.	34.	35.	42.	31.	36.5	11.
26	59.	29.35	60.	29.62	35.	34.	34.5	41.	29.	35.	12.
27	56.	29.67	63.	29.79	35.	35.	35.	42.	31.	36.5	11.
28	54.	29.91	49.	30.02	36.	37.	36.5	44.	31.	37.5	13.
29	54.	30.14	63.	30.17	37.	38.	37.5	48.	30.	39.	18.
30	65.	30.19	62.	30.15	41.	40.	40.5	51.	25.	38.	26.
31	62.	30.21	62.	30.27	41.	36.	38.5	52.	30.	41.	22.
Sum...	.....	.....	.....	.....	920.	1008.	963.0	1302.	717.	1009.5	.....
Mean..	.....	.....	.....	.....	29.6+	32.5+	31.0+	42.	23.1+	32.5+	.....

Digitized by Google

METEOROLOGICAL RECORD.

[illegible]. 43° 8′ N. Long. 70° 56′ W. Barometer 125 Feet Above Sea Level.

Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
2 p. m.	During night.	.40	.....	S. E.	Cloudy.	Maximum temperature, 56; date, 23.
5 p. m.	.....	.....	.....	N.	Cloudy.	Minimum temperature, —6; date, 1.
.....	5 p. m.	.61	.....	N. E.	Cloudy.	
.....	.....	.....	.....	N. W.	Clear.	Mean temperature (mean max. + mean min. ÷ 2), 32.5.
4 p. m.	During night.	.62	3.	S. E.	Partly cloudy.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	Mean temperature (8 + 8 + 2), 31.0.
.....	.....	.....	.....	S. W.	Clear.	
11 p. m.	.....	.....	.....	S.	Partly cloudy.	Greatest precipitation in any 24 consecutive hours, .97; date, 23-24.
.....	12 noon.	.17	.....	W.	Partly cloudy.	
.....	.....	.....	.....	N. W.	Clear.	
1 p. m.	9 p. m.	.45	.....	S.	Cloudy.	No. of clear days, 15; partly cloudy, 7; cloudy, 9; on which .01 or more precipitation fell, 10.
.....	.....	.....	.....	N. W.	Clear.	
9 a. m.	7 p. m.	.42	4.25	N. E.	Cloudy.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	S.	Partly cloudy.	Prevailing wind direction, N. W.
During night.	.....	.....	.....	S.	Cloudy.	
.....	.....	.....	.....	N. E.	Cloudy.	
.....	11 a. m.	.76	.....	S. W.	Partly cloudy.	
During night.	During night	Trace.	.....	W.	Partly cloudy.	
During night.	.....	.....	.....	S.	Clear.	
.....	During night.	.97	4.75	N. E.	Cloudy.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	N. W.	Cloudy.	
.....	.....	.....	.....	N. W.	Partly cloudy.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	4.40	12.			

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

April, 1897.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	59.	30.38	64.	30.18	37.	40.	38.5	51.	29.	40.	22.
2	58.	29.95	62.	30.10	47.	43.	45.	56.	37.	46.5	19.
3	56.	30.35	63.	30.38	30.	33.	31.5	46.	26.	36.	20.
4	57.	30.35	57.	30.08	37.	44.	40.5	58.	22.	40.	36.
5	50.	29.76	69.	29.67	38.	53.	45.5	62.	31.	46.5	31.
6	63.	29.58	72.	29.72	47.	53.	50.	63.	32.	47.5	31.
7	61.	29.88	65.	30.03	42.	40.	41.	56.	40.	48.	16.
8	52.	30.05	63.	30.08	36.	38.	37.	42.	34.	38.	8.
9	57.	29.88	58.	29.67	39.	35.	37.	44.	34.	39.	10.
10	53.	27.78	62.	29.92	37.	40.	38.5	52.	34.	43.	18.
11	53.	29.88	53.	30.02	35.	36.	35.5	38.	34.	36.	4.
12	55.	30.29	62.	30.59	41.	44.	42.5	62.	28.	45.	34.
13	65.	30.58	71.	30.29	41.	4 .	44.5	55.	26.	40.5	29.
14	64.	29.97	70.	29.98	48.	55.	51.5	65.	41.	53.	24.
15	62.	29.92	65.	29.58	44.	44.	44.	46.	43.	44.5	3.
16	65.	29.76	67.	29.83	48.	53.	50.5	65.	37.	51.	28.
17	62.	29.74	62.	29.72	44.	45.	44.5	55.	37.	46.	18.
18	62.	29.92	63.	30.06	46.	52.	49.	58.	35.	46.5	23.
19	62.	29.96	67.	29.96	54.	37.	45.5	68.	37.	52.5	31.
20	51.	30.42	57.	30.40	22.	30.	26.	34.	17.	25.5	17.
21	58.	30.5	67.	30.46	34.	43.	38.5	55.	22.	38.5	33.
22	58.	30.48	64.	30.34	50.	57.	53.5	69.	28.	48.5	41.
23	66.	30.26	74.	30.18	51.	69.	60.	80.	43.	58.5	37.
24	70.	30.08	71.	30.03	63.	69.	66.	81.	52.	66.5	29.
25	70.	29.97	73.	29.67	59.	66.	62.5	85.	45.	65.	40.
26	73.	29.74	73.	29.52	53.	50.	51.5	65.	50.	57.5	15.
27	62.	29.49	65.	29.57	43.	40.	41.5	50.	36.	43.	14.
28	61.	29.87	67.	29.96	43.	40.	41.5	50.	36.	43.	14.
29	65.	29.87	68.	29.84	50.	58.	54.	68.	35.	51.5	33.
30	70.	29.95	75.	30.06	64.	55.	59.5	75.	43.	59.	32.
Sum...	.....	.....	.....	.....	1323.	1410.	1366.5	1754.	1044.	1396.0	.....
Mean..	.....	.....	.....	.....	44.1	47.	45.5+	58.46+	34.8	46.5+	.....

Digitized by Google

METEOROLOGICAL RECORD

. 43° 8′ N. Long. 70° 56′ W. Barometer 124 Feet Above Sea Level.

Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
.....	.....	.....	.....	N. W.	Clear.	Maximum temperature, 85; date, 25.
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	Minimum temperature, 17; date, 20.
During night.	During night.	.30	.....	S.	Partly cloudy.	
During night.	During night.	.01	.....	W.	Clear.	Mean temperature (mean max. + mean min. ÷ 2), 46.6.
During night.	During night.	.05	.....	W.	Clear.	
6 p. m.	During night.	.24	.....	S.	Partly cloudy.	Mean temperature (8 + 8 ÷ 2), 45.5.
8 p. m.	.....	.....	.....	S. W.	Cloudy.	Greatest precipitation in any 24 consecutive hours, 1.17; date, 9.
.....	During night.	1.17	.....	N. E.	Cloudy.	
During night.	....	.....	.....	N. E.	Cloudy.	No. of clear days, 13; partly cloudy, 10; cloudy, 7; on which .01 or more precipitation fell, 11.
.....	5 p. m.	.16	.....	N. E.	Cloudy.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	S.	Partly cloudy.	
Showers.	.....	Trace.	.....	S. E.	Cloudy.	
.....	During night.	.33	.....	E.	Cloudy.	Prevailing wind direction, W.
.....	.....	.....	.....	W.	Clear.	
11.30 a. m.	2 p. m.	.17	.....	S. W.	Partly cloudy.	
.....	.....	.....	.....	N.	Clear.	
.....	.....	.....	.....	S. W.	Clear.	
....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	S. W.	Clear.	
.....	.....	.....	.....	S.	Partly cloudy.	
.....	.....	.....	.....	S. E.	Partly cloudy.	
.....	.....	.....	.....	S. E.	Partly cloudy.	
During night.	During night.	.04	.....	S.	Partly cloudy.	
During night.	During night.	.01	.....	W.	Cloudy.	
Showers.	.....	.02	.....	E.	Partly cloudy.	
Showers.	.....	Trace.	.....	N.	Partly cloudy.	
.....	.....	.....	.....	N. W.	Clear.	
..	....	2.50				

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

May, 1897.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	65.	30.21	63.	30.19	45.	43.	42.	48.	43.	45.5	5.
2	50.	30.03	51.	29.81	42.	43.	42.5	48.	39.	43.5	9.
3	55.	29.79	70.	28.86	48.	48.	48.	54.	44.	49.	10.
4	64.	29.84	72.	29.98	46.	46.	46.	60.	43.	51.5	17.
5	69.	29.94	70.	29.88	56.	67.	61.5	71.	36.	53.5	35.
6	65.	29.96	66.	30.	56.	48.	52.	61.	42.	51.5	19.
7	63.	30.00	59.	30.12	49.	35.	42.	52.	35.	43.5	17.
8	60.	30.3	60.	30.17	45.	50.	47.5	60.	35.	47.5	25.
9	56.	30.03	63.	29.81	52.	51.	51.5	77.	39.	57.	38.
10	54.	29.75	64.	29.79	51.	47.	49.	64.	45.	54.5	19.
11	65.	29.92	65.	29.94	58.	58.	58.	63.	45.	54.	18.
12	65.	29.95	67.	29.78	50.	62.	56.	62.	42.	52.	20.
13	65.	29.82	69.	29.7	60.	64.	62.	68.	58.	63.	10.
14	71.	29.91	68.	29.80	65.	55.	60.	69.	52.	60.5	17.
15	67.	29.90	68.	30.03	57.	68.	57.5	72.	54.	63.	18.
16	61.	29.99	64.	30.18	53.	52.	52.5	58.	46.	52.	12.
17	62.	30.15	70.	30.13	59.	57.	58.	70.	49.	59.5	21.
18	69.	30.10	75.	29.95	64.	67.	65.5	76.	45.	60.5	31.
19	71.	30.20	72.	30.20	54.	58.	56.	67.	48.	57.5	19.
20	68.	30.07	70.	29.83	62.	68.	65.	75.	43.	59.	32.
21	69.	29.61	70.	29.66	65.	57.	61.	75.	54.	64.5	21.
22	65.	29.81	68.	30.88	55.	56.	55.5	66.	44.	55.	22.
23	66.	29.98	72.	29.94	60.	58.	59.	75.	35.	55.	40.
24	65.	29.91	69.	29.86	58.	60.	59.	65.	49.	57.	16.
25	65.	29.88	68.	29.91	55.	60.	57.5	70.	52.	61.	18.
26	64.	30.02	65.	30.02	52.	55.	53.5	63.	45.	54.	18.
27	60.	29.87	74.	29.75	48.	47.	47.5	50.	47.	48.5	3.
28	62.	29.64	74.	29.71	53.	57.	55.	60.	47.	53.5	13.
29	64.	29.60	72.	29.66	54.	56.	55.	67.	50.	58.5	17.
30	73.	29.85	79.	29.83	60.	63.	61.5	74.	46.	60.	28.
31	68.	29.88	70.	29.70	55.	61.	58.	68.	52.	60.	16.
Sum ...	.....	.....	.....	.....	1682.	1712.	1690.	1998.	1404.	1705.0	.....
Mean ...	.....	.....	.....	.....	54.2+	55.2+	54.5	64.4+	45.2+	55.	.....

Digitized by Google

METEOROLOGICAL RECORD

LAT. 43° 8′ N. LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL.

May, 1897.	Precipitation.				Prevailing wind direction	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
1	During night.	During night.	Trace.	.....	S. E.	Cloudy.	Maximum temperature, 77; date, 9.
2	During night.	During night.	.02	.....	N. E.	Cloudy.	Minimum temperature, 35; date, 7, 8, 23.
3	8 a. m.	During night.	.85	.....	E.	Cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 54.8.
4	.....	.....	.....	.....	S. E.	Partly cloudy.	
5	.....	.....	.....	.....	N.	Clear.	
6	.....	.....	.....	.....	N. E.	Clear.	
7	.....	.....	.....	.....	E.	Clear.	Mean temperature (8 + 8 + 2), 54.7.
8	.....	.....	.....	.....	W.	Clear.	
9	.....	.....	.....	.....	W.	Clear.	Greatest precipitation in any 24 consecutive hours, 1.76; date, 13.
10	6 p. m.	During night.	.29	.....	S. E.	Partly cloudy.	
11	.....	During night.	Trace.	.....	S. E.	Partly cloudy.	No. of clear days, 12; partly cloudy, 6; cloudy, 13; on which .01 or more precipitation fell, 10.
12	During night.	.....	.83	.....	S. E.	Partly cloudy.	
13	.....	During night.	.93	.....	S. E.	Cloudy.	
14	.....	.....	.....	.....	S.	Cloudy.	
15	.....	.....	.....	.....	S. W.	Cloudy.	Prevailing wind direction, W. and S. E.
16	.....	.....	.....	.....	W.	Clear.	
17	.....	.....	.....	.....	W.	Clear.	
18	.....	.....	.....	.....	N. W.	Clear.	Thunder storm May 8. Began at 10.40, lasted about 10 min.
19	.....	.....	.....	.....	S. W.	Clear.	
20	.....	.....	.....	.....	S.	Partly cloudy.	
21	Showers.	.....	.01	.....	W.	Cloudy.	
22	.....	.....	.....	.....	N. W.	Clear.	Thunder in distance 25th, 5. p. m.; 29th, 10 a. m.
23	.....	.....	.....	.....	S. W.	Clear.	
24	9 a. m.	.....	.....	.....	S.	Cloudy.	
25	.....	11 a. m.	.65	.....	W.	Cloudy.	
26	During night.	.....	.....	.....	E.	Cloudy.	
27	.....	During night.	.67	.....	S. E.	Cloudy.	
28	During night.	During night.	.05	....	S.	Cloudy.	
29	.....	.....	.....	.....	S.	Partly cloudy.	
30	9 p. m.	.....	.....	.....	S. W.	Clear.	
31	.....	1 p. m.	.64	.....	W.	Cloudy.	
Sum ...	.....	.....	4.94				

Digitized by Google

METEOROLOGICAL RECORD

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE.

June, 1897.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	68.	29.79	67.	29.86	53.	59.	56.	59.	44.	51.5	15.
2	67.	30.05	71.	30.06	58.	59.	56.	68.	42.	55.	26.
3	64.	30.00	74.	29.79	53.	66.	59.5	73.	41.	57.	32.
4	68.	29.84	65.	29.92	57.	52.	54.5	60.	51.	55.5	9.
5	64.	29.85	68.	29.94	53.	54.	53.5	62.	49.	55.5	13.
6	62.	30.07	64.	30.15	52.	53.	52.5	61.	37.	49.	24.
7	62.	30.26	63.	30.22	58.	49.	51.	58.	49.	58.5	9.
8	60.	30.28	75.	30.28	51.	51.	51.	59.	43.	51.	16.
9	68.	30.22	60.	29.96	52.	51.	51.5	55.	48.	51.5	7.
10	58.	29.81	57.	29.88	54.	54.	54.5	55.	50.	52.5	5.
11	64.	29.84	70.	29.84	63.	59.	61.	76.	51.	63.5	25.
12	64.	29.78	63.	29.74	55.	48.	51.5	60.	46.	53.	14.
13	60.	29.64	60.	29.66	53.	50.	51.5	57.	46.	51.5	11.
14	60.	29.71	65.	29.77	54.	55.	54.5	67.	49.	58.	18.
15	68.	29.78	71.	29.77	63.	61.	62.	79.	51.	65.	28.
16	66.	29.72	71.	29.82	58.	63.	60.5	73.	53.	63.	20.
17	71.	29.87	75.	29.79	66.	67.	67.5	77.	49.	63.	28.
18	76.	29.78	75.	29.96	67.	59.	63.	79.	55.	67.	24.
19	77.	30.03	77.	29.96	69.	67.	68.	81.	49.	65.	32.
20	71.	29.67	73.	29.77	59.	57.	58.	68.	56.	62.	12.
21	70.	29.76	74.	29.77	57.	58.	57.5	68.	49.	58.5	19.
22	71.	29.87	75.	29.95	61.	65.	62.	78.	46.	62.	32.
23	76.	29.96	79.	29.95	68.	71.	69.5	81.	50.	65.5	31.
24	81.	29.95	85.	29.89	74.	75.	74.5	87.	58.	72.5	29.
25	80.	29.75	82.	29.63	72.	79.	75.5	87.	66.	76.5	21.
26	81.	29.83	70.	30.02	68.	58.	63.	75.	58.	66.5	17.
27	71.	30.04	71.	30.09	59.	58.	58.5	69.	45.	57.	24.
28	73.	30.05	75.	30.04	65.	67.	66.	78.	49.	63.5	29.
29	71.	30.04	70.	30.05	68.	57.	62.5	72.	57.	64.5	15.
30	67.	29.70	70.	29.77	58.	59.	58.5	65.	52.	57.5	13.
Sum	.....	.....	.....	.....	1788.	1821.	1784.5	2087.	1489.	1792.0	.....
Mean	.....	.....	.....	.....	59.6	60.7	59.4+	69.5+	49.6+	59.7+	.....

Digitized by Google

METEOROLOGICAL RECORD

. 43° 8' N. Long. 70° 56' W. Barometer 125 Feet Above Sea Level.

Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
Time of beginning.	Time of ending.	Amount in inches.	Snowfall in inches.			
Showers.	.....	.01	.....	.....	Partly cloudy.	Maximum temperature, 87; date, 24 and 25.
.....	.....	.....	.....	.....	Clear.	
12.30 p. m.	During night.	.88	.....	.....	Partly cloudy.	Minimum temperature, 37; date, 6.
1 p. m.	.....	.27	.....	.....	Cloudy.	
.....	During night.	.05	.....	.....	Cloudy.	Mean temperature (mean max. + mean min. ÷ 2), 59.5+.
.....	.....	.....	.....	.....	Cloudy.	
.....	.....	.....	.....	.....	Cloudy.	
.....	.....	.....	.....	.....	Partly cloudy.	Mean temperature (8 + 8 ÷ 2), 60.1+.
9 a. m.	.....	.....	.....	.....	Cloudy.	
.....	During night.	6.79	.....	.....	Cloudy.	Greatest precipitation in any 24 consecutive hours, 6.79; date, 9-10.
Shower at 2.30 p. m.	.....	.01	.....	.....	Clear.	
Showers.	.....	.10	.....	.....	Cloudy.	No. of clear days, 13; partly cloudy, 8; cloudy, 9; on which .01 or more precipitation fell, 11.
Showers.	.....	.08	.....	E.	Cloudy.	
Showers.	.....	.10	.....	N. E.	Partly cloudy.	
Showers.	.....	Trace.	.....	W.	Partly cloudy.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	Prevailing wind direction, W.
During night.	.....	.....	.....	S. W.	Clear.	
.....	11.30 a. m.	.11	.....	S. W.	Partly cloudy.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	N. W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	S.	Clear.	
.....	.....	.....	.....	S. W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
.....	.....	.....	.....	W.	Clear.	
8 p. m.	During night.	.02	.....	W.	Partly cloudy.	
During night.	.....	.....	.....	S.	Partly cloudy.	
.....	11 a. m.	.93	.....	S. E.	Cloudy.	
.....	.....	8.85				

Digitized by Google

METEOROLOGICAL SUMMARY.

	Average Temperature.		Precipitation.*		Snow in Inches.		No. Days .01 Inch Precipitation.		1896–'97.			
	1895–'96.	1896–'97.	1895–'96.	1896–'97.	1895–'96.	1896–'97.	1895–'96.	1896–'97.	Prevailing Wind Direction.	Days Clear.	Days Partly Cloudy.	Days Cloudy.
July	67	70	4.31	2.85	.....	.....	10	11	S. E.	16	10	5
August	67	67	2.41	3.68	.....	.....	6	9	S. E.	18	7	6
September	61	58	2.01	9.48	.....	.....	7	11	W.	15	4	11
October	45	46	4.47	2.50	.....	.....	4	13	W.	9	4	18
November	39	40	7.35	3.47	1.	1.7	14	8	W., N.W.	7	9	14
December	31	24	2.76	1.76	4.	3.5	4	5	N. W.	10	11	10
January	19	23	1.15	4.84	11.5	17.7	3	9	N. W.	16	6	9
February	23	25	5.53	2.31	19.	13.5	8	5	N. W.	14	6	8
March	28	32	6.71	4.40	12.	12.0	9	10	N. W.	15	7	9
April	44	46	.98	2.50	.....	.....	2	11	W.	13	10	7
May	58	55	2.23	4.94	.....	.....	8	10	W., S. E.	12	6	13
June	64	60	3.24	8.85	.....	.....	6	11	W.	13	8	9
Sum	546	546.	43.1	51.6	47.5	48.4	81	113	W., N.W.	158	88	119
Mean	45.5	45.5										

* Including rain, hail, sleet, and melted snow in inches.

Digitized by Google

6
Sci 1.36.35

Bulletin 49 ✓ January, 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE

INSPECTION OF FERTILIZERS

IN 1897

IN CO-OPERATION WITH THE STATE BOARD OF AGRICULTURE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1915

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director*.
FRED W. MORSE, B. S., *Vice-Director and Chemist*.
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist*.
HERBERT H. LAMSON, M. D., *Bacteriologist*.
CLARENCE M. WEED, D. Sc., *Entomologist*.

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Agriculturist and Horticulturist*.
CHARLES D. HOWARD, B. S., *Assistant Chemist*.
WILLIAM F. FISKE, *Assistant Entomologist*.
ELWIN H. FORRISTALL, B. S., *Superintendent of Farm*.
CLEMENT S. MORRIS, *Clerk*.

The Bulletins of this Station are sent free to any resident of New Hampshire upon application

Digitized by Google

THE FERTILIZER INSPECTION IN 1897

This year, as in the past, the New Hampshire College Agricultural Experiment Station has coöperated with the State Board of Agriculture in an inspection of the commercial fertilizers sold in the state.

In accordance with the public statutes, the collection of samples of the different fertilizers has been in charge of the Secretary of the Board of Agriculture, Hon. N. J. Bachelder, who has been assisted by Mr. James A. Foord; while the chemical analyses have been performed under the direction of the chemist of the Experiment Station, Prof. Fred W. Morse, who has had for assistants, Messrs. Chas. D. Howard, Chas. W. Vickery, and Ernest B. MacCready.

The following towns were visited by the agent of the Board of Agriculture, during the spring months, and samples were taken of all brands of fertilizers to be found.

LIST OF TOWNS VISITED BY THE AGENT OF THE BOARD OF AGRICULTURE

Exeter	Rockingham	County
Portsmouth	"	"
Hampton	"	"
Wilton	Hillsborough	"
Nashua	"	"
Peterborough	"	"
Keene	Cheshire	"
Hinsdale	"	"
Walpole	"	"
Charlestown	Sullivan	"
Claremont	"	"
Contoocook	Merrimack	"
Franklin Falls	"	"
Henniker	"	"

Digitized by Google

Concord	Merrimack	County.
Penacook	"	"
Tilton	Belknap	"
Lakeport	"	"
Laconia	"	"
Rochester	Strafford	"
Dover	"	"
Madbury	"	"
Milton	"	"
Ossipee	Carroll	"
Center Ossipee	"	"
Centerville	"	"
Wolfeborough	"	"
Plymouth	Grafton	"
West Rumney	"	"
Haverhill	"	"
North Haverhill	"	"
Lancaster	Coös	"
Colebrook	"	"

The result was the collection of 258 samples, divided between 112 distinct brands of mixed fertilizers, representing the following manufacturers.

LIST OF MANUFACTURERS

American Fertilizer Co.	3	brands
Bowker Fertilizer Co.	11	"
Bradley Fertilizer Co.	10	"
Baugh & Sons' Co.	4	"
Clark's Cove Fertilizer Co.	3	"
Cleveland Dryer Co.	2	"
Crocker Fertilizer and Chemical Co. (Buffalo)	4	"
Cumberland Bone Phosphate Co.	3	"
L. B. Darling Fertilizer Co.	6	"
John C. Dow & Co.	2	"
E. Frank Coe Co.	6	"
Great Eastern Fertilizer Co.	4	"
D. C. Hawes	1	"

Digitized by Google

Lister's Agricultural Chemical Works	4	brands
Lowell Fertilizer Co. (Swift's)	8	"
Pacific Guano Co.	4	"
Packers' Union Fertilizer Co.	4	"
Parmenter & Polsey Fertilizer Co.	4	"
Quinnipiac Company	4	"
Read Fertilizer Co.	9	"
Russian Cement Co. (Essex)	4	"
Standard Fertilizer Co.	3	"
Henry F. Tucker Co.	1	"
Walker, Stratman & Co.	4	"
Williams & Clark Fertilizer Co.	4	"

The work of the inspectors in this state cannot be done before the farmers buy their season's stock of fertilizers, because the manufacturers do not, in many cases, place their goods in the hands of the local agents until April 1, or later. Consequently the analyses of the past year must serve as a guide to the composition of the fertilizers on the market for the coming year. The publication of this bulletin has therefore been delayed, with the idea that it will receive more attention now than if issued last fall, and thus it will be more effective in decreasing the use of inferior brands.

Digitized by Google

COMPOSITION OF MIXED FERTILIZERS COLLECTED BY THE STATE BOARD OF AGRICULTURE, 1897.

Number.	Manufacturer and Brand.	Number of samples.	Nitrogen in 100 Lbs.		Phosphoric Acid in 100 Lbs.							Potassium Oxide in 100 Lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	American Fertilizer Co.												
1	General American for all crops	3	1.65	1.65	.57	5.26	8.82	14.65	9.00	5.83	6.00	2.85	2.00
2	Potato Fertilizer	1	2.47	2.47	.31	5.55	4.96	10.82	.....	5.86	6.00	8.82	9.00
3	Alkali Nitrate Phosphate for Grass and Grain	1	3.99	3.90		2.05	10.55	12.60	17.00	2.05	.....	3.35	3.00
	Bowker Fertilizer Co.												
4	Bowker's Hill and Drill Phosphate	5	2.68	2.47	7.28	4.76	1.69	13.73	12.00	12.04	9.00	2.62	2.00
5	Bowker's Farm and Garden Phosphate	4	1.95	1.65	5.03	3.81	3.06	11.90	10.00	8.84	8.00	2.54	2.00
6	Bowker's Sure Crop Phosphate	2	1.06	.75	6.29	3.37	2.74	12.40	10.00	9.66	8.00	1.51	1.00
7	Bowker's Potato and Vegetable Manure	3	2.45	2.50	7.55	2.32	1.90	11.77	10.00	9.87	8.00	4.42	4.00
8	Bowker's Square Brand Bone and Potash	1	1.82	1.50	2.25	7.30	3.67	13.22	12.00	9.55	6.00	2.43	2.00
9	Bowker's Special for Corn, Grain, and Fodder Corn	1	2.25	1.75	7.38	1.68	2.04	11.30	12.00	9.26	6.00	4.36	4.25
10	Bowker's Potash Phosphate	1	.97	.75	5.40	3.81	2.72	11.93	10.00	9.21	8.00	3.65	3.00
11	Stockbridge Manure for Potatoes and Vegetables	4	3.15	3.20	6.56	1.90	1.29	9.75	7.00	8.46	5.00	10.48	10.00
12	Stockbridge Manure for Top-dressing	2	5.02	4.94	4.36	2.42	2.22	9.00	6.00	6.78	4.00	6.79	6.00
13	Stockbridge Manure for Seeding Down	1	2.24	2.25	2.70	3.76	4.82	11.28	10.00	6.46	6.00	10.14	10.00
14	Stockbridge Manure for Corn, Grain, and Fodder Corn	1	2.98	3.00	7.59	1.23	1.58	10.40	10.00	8.82	7.00	7.46	6.00

Digitized by Google

	HENRY F. TUCKER CO.												
15	Tucker's Original Bay State Bone Superphosphate	2	2.27	2.00	6.00	4.02	2.20	12.22	11.00	10.02	9.00	2.26	2.00
	BRADLEY FERTILIZER CO.												
16	Bradley's Eclipse Phosphate	5	1.93	1.00	6.18	3.38	2.24	11.80	12.00	9.56	10.00	2.13	1.50
17	Bradley's Corn Phosphate	5	2.27	2.06	6.72	2.78	2.15	11.65	10.00	9.50	9.00	1.76	1.50
18	Bradley's Potato Manure	5	2.42	2.50	4.95	2.30	1.89	9.14	8.00	7.25	6.00	5.80	5.00
19	Bradley's X. L. Superphosphate	5	2.58	2.50	6.29	3.60	2.44	12.33	11.00	9.89	9.00	2.33	2.00
20	Original Coe's Superphosphate	3	2 27	2.05	9.38	.13	2.49	12.00	10.00	9.51	8.00	1.70	1.00
21	Bradley's Complete Manure for Top-dressing	5	5.00	4.95	1.87	5.42	1.56	8.85	6.00	7.29	5.00	2.94	2.50
22	Bradley's Potato Fertilizer	2	2.31	2.06	5.77	3.76	3.27	12.80	11.00	9.53	9.00	3.35	3.25
23	Bradley's Complete Manure for Potatoes and Vegetables	5	3.71	3.73	5.90	2.66	2.06	10.62	9.00	8.56	8.00	6.65	6.00
24	Bradley's Complete Manure with 10 per cent. Potash	1	3.19	3.30	5.15	4.12	1.66	11.23	7.00	9.57	6.00	9.90	10.00
25	Bradley's Seeding Down Manure	2	2.62	2.50	6.64	3.15	2.86	12.65	12.00	9.79	7.00	2.13	2.00
	BAUGH & SONS' CO.												
26	The $25.00 Phosphate	1	2.40	2.06	6.95	1.85	3.53	12.33	.....	8.80	7.00	1.98	.50
27	Baugh's Special Potato Manure	1	2.10	1.65	6.43	.41	2.31	9.15	7.50	6.84	5.00	10.78	10.00
28	Baugh's General Crop Grower	1	1.36	.62	6.55	2.26	2.10	10.91	.....	8.81	8.00	2.25	1.00
29	The Economical Fertilizer	1	2.03	1.65	5.52	2.93	3.90	12.35	.....	8.45	7.00	2.67	2.00
	D. C. HAWES.												
30	Granite State Fertilizer	1	2.68	1.65	1.73	3.22	3.18	8.13	8.00	4.95	5.00	3.98	4.00
	CLARK'S COVE FERTILIZER CO.												
31	'King Philip Alkaline Guano for Potatoes	1	1.37	1.23	6.02	2.52	1.53	10.07	8.00	8.54	6.50	4.18	3.00
32	Clark's Cove Potato and Tobacco Fertilizer	2	2.82	2.06	5.93	2.97	2.43	11.33	9.00	8.90	8.00	3.71	3.00
33	Clark's Cove Bay State Fertilizer	2	2.20	1.65	5.90	3.23	2.04	11.22	10.00	9.18	8.50	2.53	2.00
	CLEVELAND DRYER CO.												
34	Cleveland Superphosphate	2	2.23	2.05	5.50	3.39	2.36	11.25	11.00	8.89	9.00	2.16	2.00
35	Cleveland Potato Phosphate	3	2.28	2.05	6.58	2.96	2.75	12.29	10.00	9.54	8.00	3.50	3.00

Digitized by Google

COMPOSITION OF MIXED FERTILIZERS COLLECTED BY THE STATE BOARD OF AGRICULTURE, 1897.—*Continued.*

Number.	Manufacturer and Brand.	Number of samples.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Cumberland Bone Phosphate Co.												
36	Cumberland Potato Fertilizer	2	2.39	2.06	4.90	4.11	3.24	12.25	11.00	9.01	9.00	3.28	3.00
37	Cumberland Superphosphate	3	2.23	2.06	5.58	3.71	2.10	11.39	10.00	9.29	8.00	2.16	2.00
38	Cumberland Fertilizer	1	1.20	1.06	6.50	1.91	1.57	9.98	10.00	8.41	8.00	2.21	2.00
	Croker Fertilizer and Chemical Co.												
39	Croker's Ammoniated Corn Phosphate	5	2.01	2.00	7.53	3.14	1.21	11.88	11.00	10.67	10.00	2.04	1.60
40	Croker's Potato, Hop, and Tobacco Phosphate	5	2.25	2.00	7.67	3.09	.84	11.60	11.00	10.76	10.00	3.48	3.25
41	Croker's New Rival Ammoniated Superphosphate	5	1.25	1.23	6.75	3.20	1.28	11.23	11.00	9.95	10.00	1.97	1.80
42	Croker's Superior Rye and Oats Fertilizer	1	.93	.82	6.01	3.25	1.53	10.79	9.00	9.26	8.00	2.12	2.00
	Standard Fertilizer Co.												
43	Standard Fertilizer	1	2.12	2.00	5.58	3.79	2.12	11.49	10.00	9.37	8.00	1.95	2.00
44	Standard Guano	1	1.10	1.06	5.04	2.90	1.66	9.60	10.00	7.94	8.00	2.32	2.00
45	Standard Potato and Tobacco Fertilizer	1	2.26	2.06	5.57	4.13	2.53	12.23	9.00	9.70	8.00	3.42	3.00
	L. B. Darling Fertilizer Co.												
46	Darling's Farm Favorite	1	3.07	2.00	3.97	3.84	2.73	10.54	8.00	7.81	6.00	6.58	5.00
47	Darling's Animal Fertilizer	1	3.15	3.30	3.21	5.69	5.06	13.96	10.00	8.90	6.00	4.50	4.00
48	Darling's New Hampshire Special	4	3.19	3.00	3.46	4.55	3.84	11.85	11.00	8.01	8.00	8.00	8.00

Digitized by Google

49	Darling's Blood, Bone, and Potash	1	4.00	4.50	4.91	3.90	1.97	10.78	9.00	8.81	7.00	8.42	7.00
50	Darling's Potato and Root Crop Manure	1	2.80	2.88	3.53	4.59	5.00	13.12	10.00	8.12	7.00	9.28	7.00
121	Darling's L. I. C. Brand	1	3.67	4.00	2.49	3.67	2.90	9.06	.....	6.16	6.00	10.06	10.00
	JOHN C. DOW & CO.												
51	Dow's Nitrogenous Superphosphate for Potatoes	1	1.96	2.06	3.03	7.15	1.02	11.20	.....	10.18	8.00	4.55	4.00
52	Dow's Nitrogenous Superphosphate	1	2.42	2.06	3.15	8.91	1.94	14.00	.....	12.06	8.00	2.49	1.85
	LOWELL FERTILIZER CO.												
53	Swift's Lowell Animal Brand	2	2.41	2.46	5.45	4.13	1.46	11.04	10.00	9.58	9.00	4.24	4.00
54	Swift's Lowell Fruit and Vine Brand	1	2.41	2.47	4.94	3.58	1.44	9.96	9.00	8.52	8.00	6.35	6.00
55	Swift's Lowell Bone Fertilizer for Corn and Grain	5	2.27	1.65	4.82	2.99	1.72	9.53	9.00	7.81	8.00	3.50	3.00
56	Swift's Lowell Complete Manure for Vegetables	5	2.22	2.00	5.29	3.80	1.54	10.63	9.00	9.09	8.00	3.90	3.50
57	Swift's Lowell Empire Brand	5	1.24	1.23	3.20	3.11	1.94	8.25	8.00	6.31	7.00	2.17	2.00
58	Swift's Lowell Potato Phosphate	4	2.68	2.47	7.25	2.16	1.22	10.63	9.00	9.41	8.00	5.85	6.00
59	Swift's Lowell Lawn Dressing	1	4.60	4.12	5.00	2.48	3.52	11.00	9.00	7.48	8.00	5.36	5.00
60	Swift's Lowell Dissolved Bone and Potash	2	1.57	1.65	6.44	3.07	2.81	12.32	10.00	9.51	9.00	2.17	2.00
	E. FRANK COE CO.												
61	E. F. Coe's Celebrated Special Potato Fertilizer	1	1.77	1.65	7.74	1.78	2.94	12.46	11.00	9.52	9.00	3.80	3.50
62	E. F. Coe's High Grade Ammoniated Bone Superphosphate	3	2.11	2.00	7.61	1.95	2.45	12.01	11.00	9.56	9.00	2.07	1.85
63	E. F. Coe's Celebrated Grass and Grain Fertilizer	3	1.23	.80	8.55	1.84	3.11	13.50	10.00	10.39	9.00	2.01	1.35
64	E. F. Coe's Ground Bone and Potash	1	1.67	2.00	.....	2.78	12.40	15.18	.....	2.78	.....	3.56	2.50
65	E. F. Coe's Columbian Corn Fertilizer	2	1.48	1.20	7.60	1.40	3.66	12.66	11.00	9.00	9.00	2.00	1.85
66	E. F. Coe's Columbian Potato Fertilizer	2	1.45	1.20	7.79	1.83	3.31	12.93	11.00	9.62	9.00	1.97	1.85
	GREAT EASTERN FERTILIZER CO.												
67	Great Eastern Potato Manure	4	2.20	2.06	2.65	5.53	3.12	11.30	9.00	8.18	8.00	4.21	4.00
68	Great Eastern Grass and Oat Fertilizer	1	.....	.....	6.53	5.42	1.50	13.45	.....	11.95	11.00	2.12	2.00
69	Great Eastern General Fertilizer	3	1.34	.82	3.15	4.33	2.76	10.24	9.00	7.48	8.00	4.13	4.00
70	Great Eastern High Grade Corn Fertilizer	3	2.98	2.88	2.93	4.20	3.55	10.68	9.00	7.13	8.00	2.64	2.00

Digitized by Google

COMPOSITION OF MIXED FERTILIZERS COLLECTED BY THE STATE BOARD OF AGRICULTURE, 1897—*Continued.*

Number.	Manufacturer and Brand.	Number of samples.	Nitrogen in 100 Lbs.		Phosphoric Acid in 100 Lbs.							Potassium Oxide in 100 Lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Lister's Agricultural Chemical Works.												
71	Lister's Special Potato Fertilizer	5	1.71	1.65	6.88	2.65	2.39	11.92	9.00	9.53	8.00	3.54	3.00
72	Lister's Success Fertilizer	5	1.50	1.24	8.46	1.66	2.52	12.64	11.50	10.12	9.50	2.20	2.00
73	Lister's Seeding Down Fertilizer	3	1.42	1.32	5.92	2.18	2.23	10.33	8.00	8.10	7.00	2.21	2.00
74	Lister's Potato Manure	1	2.39	3.70	8.77	1.18	2.20	12.15	8.50	9.95	7.50	7.65	7.00
	Packer's Union Fertilizer Co.												
76	H. G. Potato Manure	2	2.15	2.06	7.14	1.10	1.85	10.09	9.00	8.24	8.00	6.45	6.00
77	H. G. Wheat, Oats, and Clover Fertilizer	2	.....	.....	7.01	3.53	2.28	12.82	.....	10.54	11.00	1.98	2.00
78	Animal Corn Fertilizer	1	2.64	2.47	7.04	.99	1.94	9.97	9.00	8.03	8.00	2.38	2.00
79	High Grade Universal Fertilizer	1	1.08	.82	6.40	1.61	1.30	9.31	9.00	8.01	8.00	4.99	5.00
	Pacific Guano Co.												
80	Soluble Pacific Guano	5	2.20	2.25	5.77	2.82	2.74	11.33	10.50	8.59	8.50	2.03	2.00
81	Nobsque Guano	1	1.06	1.15	7.07	0.37	2.29	9.73	9.00	7.44	8.00	2.52	2.00
82	Special for Potatoes and Tobacco	2	2.28	2.06	5.20	3.01	3.77	11.98	9.00	8.21	6.00	2.85	3.00
83	A No. 1 Phosphate	1	1.15	1.00	5.59	2.63	1.91	10.13	9.00	8.22	7.00	2.25	1.50
	Parmenter & Posley Fertilizer Co.												
84	Star Brand Superphosphate	1	1.86	1.65	3.96	3.96	1.06	9.00	8.00	7.94	7.00	2.42	2.50
85	Plymouth Rock Brand	1	2.74	2.47	4.54	3.89	1.55	9.98	9.00	8.43	8.00	4.82	4.00
86	Special Potato Fertilizer	1	3.08	2.79	4.81	4.39	2.00	11.20	9.00	9.20	8.00	6.44	7.00
87	A. A. Brand Fertilizer	1	4.38	4.12	3.25	4.21	2.72	10.18	10.00	7.46	9.00	8.80	10.00

Digitized by Google

	READ FERTILIZER CO.												
88	**Read's Standard Superphosphate**	4	1.10	.82	6.41	2.11	1.23	9.75	9.00	8.52	8.00	4.09	4.00
89	**Read's Sure Catch Fertilizer**	2	.....	.....	4.34	2.32	1.18	7.84	7.00	6.66	6.00	4.50	4.00
90	**Vegetable and Vine Fertilizer**	3	1.95	1.85	5.06	1.87	1.36	8.29	7.00	6.93	6.00	8.46	8.00
91	Practical Potato Special	4	1.03	.82	4.58	.15	.82	5.55	5.00	4.73	4.00	8.20	8.00
92	Fish, Bone, and Potash	3	2.55	2.47	2.97	1.38	1.63	5.98	5.00	4.35	4.00	4.47	4.00
93	Leader Guano	3	1.05	.82	4 98	2.97	1.10	9.05	8.00	7.95	7.00	2.37	2.00
94	Farmers' Friend Superphosphate	2	2.23	2.06	7.16	2.72	1.71	11.59	10.00	9.88	9.00	2.50	2.00
95	High Grade Farmers' Friend	1	3.61	3.29	4.80	1.45	1.52	7.77	6.00	6.25	5.00	10.02	10.00
96	Cereal Special	1	1.86	1.65	4.38	2.52	1.52	8.42	7.00	6.90	6.00	4.45	4.00
	QUINNIPIAC CO.												
97	**Quinnipiac Potato Phosphate**	5	2.29	2.05	5.86	2.57	3.48	11.91	9.00	8.43	8.00	3.37	3.00
98	**Quinnipiac Corn Manure**	5	2.35	2.06	5.40	3.49	3.12	12.01	10.00	8.89	9.00	2.00	1.50
99	**Quinnipiac Mohosok Fertilizer**	1	1.21	.82	6.26	1.51	1.77	9.54	8.00	7.77	7.00	1.46	1.00
100	**Quinnipiac Climax Phosphate**	1	1.24	1.03	4.97	2.81	2.35	10.13	9.00	7.78	8.00	2.49	2.00
	RUSSIAN CEMENT CO.												
101	Essex XXX Fish and Potash	5	2.43	2.10	3.07	5.77	5.78	14.57	12.00	8.84	10.00	2.83	2.25
102	Essex Complete Manure for Potatoes, Roots and Vegetables	3	4.34	3.70	4.19	3.66	3.03	10.88	9.00	7.85	7.00	9.05	8.50
103	Essex High Grade Superphosphate	1	2.81	2.50	3.32	5.83	4.70	13.85	11.00	9.15	9.00	4.98	4.00
104	Essex Complete Manure for Corn and Grass	1	3.90	3.70	4.38	4.44	3.30	12.12	9.50	8.82	7.00	9.98	9.50
	WALKER, STRATMAN & CO.												
105	Four-fold Fertilizer	3	1.38	.82	5.87	2.73	2.88	11.48	11.00	8.60	8.00	1.99	1.00
106	Potato Special Fertilizer	2	1.80	1.65	6.46	2.16	3.57	12.19	13.00	8.62	9.00	6.40	5.00
107	Big Bonanza Fertilizer	1	1.78	1.65	7.38	2.56	3.70	13.64	15.00	9.94	11.00	2.58	2.00
108	Smoky City	1	1.75	1.23	9.50	2.03	2.03	13.56	15.00	11.53	12.00	1.18	1.00
	WILLIAMS & CLARK FERTILIZER CO.												
109	W. & C.'s Americus Ammon. Bone and Superphosphate	1	2.72	2.47	6.97	2.37	2.16	11.50	10.00	9.34	9.00	3.14	2.00
110	Prolific Crop Producer	1	1.07	.88	6.45	1.86	1.88	10.19	7.00	8.31	6.00	2.19	1.00
111	Americus Corn Phosphate	1	2.20	2.06	4.57	3.59	3.09	11.25	10.00	8.16	9.00	2.74	1.50
112	Americus Potato and Tobacco Manure	1	2.20	2.06	6.21	2.56	3.20	11.97	9.00	8.77	8.00	4.37	3.00

Digitized by Google

COMPOSITION OF FERTILIZER CHEMICALS COLLECTED BY THE STATE BOARD OF AGRICULTURE.

	Constituents in 100 Lbs.					
	Nitrogen.	Soluble Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Available Phosphoric Acid.	Potash.
Bradley Fertilizer Co.						
Muriate of Potash	.....	.....	.....	.....	.....	50.00
Sulphate of Ammonia	20.40	.....	.....	.....	.....	.....
Fine Ground Bone	2.75	.....	10.90	19.40	8.50	.....
Dissolved Bone Black	.....	15.60	.50	16.80	16.30	.....
Joseph Breck & Sons.						
Bone Meal for Poultry and Lawns	2.27	.....	16.70	18.60	1.90	.....
Bowker Fertilizer Co.						
Bowker's Fresh Ground Bone	2.75	.....	7.80	18.90	11.10	.....
Manchester Slaughtering and Rendering Co.						
Tankage	5.12	.....	8.15	17.20	9.05	.....
E. Frank Coe Co.						
Pure Fine Ground Raw Bone	3.75	.....	.....	18.35	.....	.....

Digitized by Google

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS. 1897.

	Cents per pound.
Nitrogen in ammonia salts	13.5
" nitrates	14.
" dry and fine ground fish, meat, and blood and in high grade mixed fertilizers	14.
Nitrogen in cotton-seed meal, linseed meal and castor-pomace	12.
Nitrogen in fine ground bone and tankage	13.5
" medium ground bone and tankage	11.
" coarse bone and tankage	8.
Phosphoric acid soluble in water	5.5
" " " ammonium citrate (reverted)	5.
" " in fine ground bone and tankage	5.
" " in medium ground bone and tankage	4.
" " in coarse bone and tankage	2.5
" " in fine ground fish, cotton-seed meal, linseed meal, castor-pomace, and wood-ashes	5.
" " insoluble in mixed fertilizers	2.
Potash as sulphate free from chlorides and in wood ashes	5.
" " muriate	4.5

The above values are based on the wholesale market prices for the materials, when sold in large lots at the principal trade centers in New England. The valuation of a ton of any mixed fertilizer based on the above figures will usually fall ten dollars below the retail price at the local agency. This variation includes such fixed charges as cost of mixing, bags, cartage and freight, salaries and commissions of agents, and interest.

Digitized by Google

FERTILIZER NOTES FOR 1897

BY FRED W. MORSE

Fertilizers, during the year just ended, have been lower in price than ever before, and the indications are that they will be even cheaper during the year to come. The result of the cheapening of the chemical constituents has been to raise the quality of the mixed fertilizers somewhat above the minimum guarantee and consequently there are very few samples showing deficits in their composition. Out of 448 separate guarantees, only 28 failed to either exceed the requirements or come within the limits of error in sampling and analyzing. These exceptions included five guarantees of nitrogen, seven of total phosphoric acid, 14 of available phosphoric acid and two of potash, and were scattered through 24 distinct brands representing 18 different manufacturers, thus indicating that there was no attempt at fraud, but either slight carelessness or accident in mixing and bagging the materials. In no case would the guaranteed value have been noticeably affected.

A study of the tabulated analyses has shown a few points that are of importance to the user of ready mixed chemical fertilizers.

One hundred and twelve different brands of mixed fertilizers are included in the tables. Of these, 56 brands are not guaranteed to contain more than two per cent. of nitrogen, and 51 brands more than two per cent. of potash. Only 15 brands are claimed to contain more than three per cent. of nitrogen and but 17 brands to contain more than six per cent. of potash. On the other hand 73 brands are claimed to contain more than eight per cent. of available phosphoric acid.

It may thus be easily seen that the average buyer of fertilizers is purchasing regularly about four times as much phos-

Digitized by Google

phoric acid as nitrogen and from two to four times as much phosphoric acid as potash. The persistent use of the average fertilizer must then result in an accumulation of useless phosphoric acid in the soil, accompanied by an exhaustion of the soil's available nitrogen and potash, and in diminishing crops. On most of our New Hampshire soils such a fertilizer will need to be employed in conjunction with barn-yard manure, to be economical, since the manure will supply the nitrogen and potash, which the fertilizer lacks.

Thirty-one brands are not warranted to contain more than 1.5 per cent. of nitrogen, and have been prepared and placed on the market, because of the demand for cheap fertilizers. Nitrogen is the most expensive ingredient of a fertilizer, costing about three times as much as either potash or available phosphoric acid, and is invariably the constituent to be lowered in a mixed fertilizer in order to reduce the price.

It is only in exceptional soils, such as new ground or land previously heavily manured, that crops will receive nitrogen sufficient for successful growth when such low grade fertilizers are applied. Several letters have been received during the past year, testifying to the disappointment liable to be incurred by the users of fertilizers containing small proportions of active nitrogen.

The buyers of ready-mixed fertilizers should bear in mind that it is as important that they study the composition of the fertilizers as that the station chemist does. In the latter case it is essential to know merely that the analyses and guarantees are alike, while in the former case it is necessary to know that the composition is suitable for the uses intended. The name of a brand is no indication that it is suitable for a special crop. Hardly two manufacturers agree in their special fertilizers for corn and similar crops, while some companies issue not less than three distinct mixtures each for such a crop as potatoes.

It should also be remembered that there is no "best fertilizer" made, but each farmer may by careful observation determine those brands which serve his purpose best, and he should know them by their composition, instead of simply by name or price. A comparison of the constituents of any ten

Digitized by Google

fertilizers reported in the foregoing table should convince the user of commercial fertilizers that they cannot be bought haphazard and return a profit to the buyer. The user must try to find out the class of mixture that he needs and thus avoid purchasing unnecessary ingredients while failing to secure necessary ones.

Digitized by Google

APPENDIX

PUBLIC STATUTES OF NEW HAMPSHIRE

CHAPTER 126

FERTILIZERS

SECTION 20. Every person manufacturing or importing fertilizers to be sold or offered for sale within this state shall obtain a license from the state treasurer, countersigned and recorded by the secretary of the board of agriculture, authorizing such sale. The license shall be for one year, and the party to whom it is granted shall pay therefor fifty dollars, for the use of the state.

SECT. 21. Every such person shall cause to be affixed to every bag, barrel, or parcel of fertilizer to be sold or offered for sale within this state, a written or printed label which shall correctly state his name, his place of business, the number and date of his license, the name of the fertilizer, the date of its manufacture, the percentage of ammonia, nitrogen, soluble phosphoric acid, insoluble phosphoric acid, potash, and its other constituent parts, and the words, "State of New Hampshire—Licensed." By the term "soluble phosphoric acid" is meant such acid in any form or combination when readily soluble in pure water; and by "insoluble phosphoric acid," such as requires the action of acid to render it thus soluble.

SECT. 22. Any manufacturer or importer of fertilizers for sale within this state who does not obtain a license authorizing such sale, or affix to the bags, barrels, or parcels of fertilizers to be sold or offered for sale in this state a label containing the information required by the preceding section, or who affixes a label to such packages containing false information as to any of said particulars, shall forfeit five hundred dollars for each offense, one half for the use of the prosecutor, and the other half for the use of the state.

Digitized by Google

SECT. 23. Any person who sells or keeps for sale any fertilizer not labeled as required by Section twenty-one of this chapter, or which has a label affixed thereto giving false information as to any of said particulars, or the sale of which is not duly licensed, shall be fined twenty dollars for the first offense and forty dollars for each subsequent offense, one half for the use of the prosecutor, and the other half for the use of the state.

SECT. 24. The money received for license fees by virtue of Section twenty of this chapter is appropriated for the following purposes: A sufficient sum to pay the College of Agriculture and the Mechanic Arts the actual expenses of making analyses of fertilizers and other substances submitted to the college by the board of agriculture for analysis, and the balance thereof to pay the expenses of farmers' meetings held in winter months under the authority of the board of agriculture.

CHAPTER 12

STATE BOARD OF AGRICULTURE

SECTION 9

DUTIES OF THE SECRETARY

LINE 11. He shall collect samples of fertilizers sold in this state, and any other articles which the interests of agriculture may require, and submit them to the College of Agriculture and the Mechanic Arts for chemical analysis.

Digitized by Google

Digitized by Google

Digitized by Google

A
Sci 10 36.35

Bulletin 50 ✓ February, 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DEHORNING CATTLE

BY F. WM. RANE AND H. H. LAMSON

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM

Digitized by Google

HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1936

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. SC., *Entomologist.*

ASSISTANTS

ELWIN H. FORRISTALL, B. S., *Superintendent of Farm.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
ERNEST J. RIGGS, B. S., *Assistant Horticulturist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

DEHORNING CATTLE

I. EXPERIENCE WITH THE COLLEGE HERD

BY F. WM. RANE

Beginning with the years 1885 and 1886, the practice of dehorning cattle has rapidly grown in favor, until at present it is commonly practised in many sections. Illinois is credited with being the first state to advocate it. From the first many have strenuously objected to it, numerous lawsuits resulting therefrom. Most of these prosecutions have taken place under the law for the prevention of cruelty to animals. Many states have had test cases, but no one in the United States, so far as we can learn, has been convicted where the case has been carried to the higher courts. Canada has gone farther than any other country in instigating legal proceedings to settle the question. A commission was appointed by the government, which reported in 1892 in favor of the operation when performed with reasonable skill.

During the past year the college herd was dehorned, the data from which operation form the basis for this bulletin. This is not the first dehorning that has been done in the state. In the northern part it is very commonly practised, while in the southern most of the dehorned animals are those that have been shipped from the north. One farmer who purchased some of these cows was so well pleased with them that he has operated on his remaining herd of twenty-nine animals.

One of last winter's dairy school students, Mr. E. Richardson, and his brother purchased a pair of Keystone clippers two years ago, and after operating upon their own herd, made a business of dehorning for others at the rate of fifteen cents per head. Up to the present time they have dehorned over 1,500 animals in and about Littleton.

Digitized by Google

Mr. L. J. Miner, of Whitefield, a member of the State Board of Agriculture, tells me that all farmers in his section are more than pleased with dehorning, and that it is quite the exception to see a herd of horned animals. If we can judge other towns in the northern part of the state by these reports, it is safe to conclude that this practice is rapidly gaining in favor throughout this section.

Mr. H. E. Forristall, of Columbia, states that dehorning steers is a financial benefit. He claims that where the horns are off, they put on flesh and retain it, while with horns much of the food and nourishment is spent in exercise and in worrying one another. As an example, a year ago, one of our cows slunk her calf in the pasture, because of another's hooking her. Actual danger of this kind is one of the chief reasons in favor of the practice of removing the horns.

The following notes were obtained through the coöperation of Mr. Leigh Hunt, who was assistant in this department last year. On April 7th last, he, together with the herdsman, dehorned a Jersey grade (Ann), using the Keystone clippers. No special device was constructed for holding the animal, and the work was accomplished by tying her to one of the brick pillars in the barn basement, placing her head against the pillar when the operation was performed. This means of holding the animal did not prove satisfactory. During the struggle after the first horn was removed, she threw her head heavily against the pillar, slightly loosening the uncut horn. After the other was removed, she bled very freely. A bandage with pine tar and cotton-seed meal was then applied. The bleeding continued for about an hour, the bandage checking it to a great extent. The operation was performed about eleven o'clock in the morning. The animal ate very little at noon and was very much excited. At night her food was taken about as usual. On the next and the succeeding days there was but little difference noticeable in her eating. Her milk flow dropped off slightly.

Before operating farther, a strong stanchion was erected, a cut of which is shown in figure 2.

On April 13th, three more Jerseys (Cream Cup, Countess, and Bertha) were dehorned. The operation was performed

Digitized by Google

at three o'clock. Three hours later, the blood had ceased flowing. In the night Cream Cup bled very freely again, making her rather weak by morning, by which time bleeding had ceased. Her appetite was very poor for several days, omitting a few meals altogether. The other two cows suffered very lit-

Fig. 2. The stanchion used in dehorning the College herd. Performing the operation.

tle; they did not eat quite as much food for a few days, but rallied quickly.

April 29, the four bulls of the college herd, two Ayrshires, ages sixteen months and five years respectively, a Guernsey, four years, and a Jersey, three years, together with three cows were operated upon. All the horns were easily cut off excepting those of the older bulls, which required an extra man at the handles. When cutting Alton's, the older Ayrshire, one of the

Digitized by Google

handles of the clippers was broken, which we replaced by a strong hickory one. This is liable to occur; hence it is advisable to have an extra handle.

The bulls did not seem to bleed as much as many of the cows, nor for so long a time. They lost little, if any, appetite, and the removal of their horns has made them comparatively quiet and gentle. Up to the present time they have been used for service repeatedly and without any apparent loss of power or inclination. Previous to dehorning, it was our custom to hitch one at a time to a ring and chain, shown on the cover page, this being suspended from a strong cable running the length of the yard, thus giving each daily exercise. This same figure shows the present method; all run together, can be left out longer, and get more exercise from playing with one another, and there is scarcely any danger when handling them, all three being driven in and out together like calves. One can scarcely realize the difference in the amount of work, to say nothing of the lessened danger.

The following day, April 30th, the men dehorned the remainder of the herd, twenty-two cows. The work was begun at about 8 a. m., and all was completed in one hour and forty minutes. The time necessary, therefore, for one operation was on the average only four and one-fourth minutes. In each case, the blood spurted out in a single jet, one from each horn, to a distance varying from three to six feet, gradually subsiding as it began to clot. Nothing was done to check the flow from the last animals, and they stood the test fully as well as the others.

Two Holsteins, one thoroughbred Durham (Dorothy), and a thoroughbred Jersey (Madge Berg 2d), seemed to be the least affected of any of the cows. They scarcely seemed to notice the operation at the time; also recovered quickly. The loss of milk was very small in these cases. One Holstein actually gained in quantity, which, however, was due to the fact that she had calved on the 25th, and had not yet reached the limit of her production. Her increase was constant until the maximum was reached.

In point of breeds, the Ayrshires were the most seriously affected. At the time they seemed to stand it the best, but with the exception of one (Bonnie), they all showed considerable

Digitized by Google

weakness, losing appetite and ambition, besides dropping off in milk and general appearance. Belle,—at the time, the heaviest milker,—seemed to lose the most blood during the night, and her milk flow was reduced from 34.4 pounds to 5.5 pounds the following day, but gradually recovered. Her horns were very large, and difficult to cut. Another Ayrshire (Maid of Chaos) again started to bleed on the following day, but it was easily checked. The loss of blood did not seem to weaken her.

It is now ten months since the operations. All of the animals regained their original vigor in a short time. The general air and disposition of the herd is changed. The former worry and uneasiness, as well as the fierceness previously shown just before feeding times, have disappeared.

CONCLUSIONS

As has already been indicated, it is believed that dehorning not only eliminates the danger to life, and is therefore of the utmost importance; but it has its economic bearing as well. It is well understood, that where milch cows are gently cared for, and not over exercised, other things being equal, more milk is produced. For the same reason it is evident that beef animals will gain more rapidly where hornless, the nourishment exhausted in fighting tendencies being stored up as flesh. Animals are more cheaply transported by live weight, when dehorned, as more can be accommodated in less space and with less danger.

I have yet to see the average herd of horned animals without its recognized leaders and masters; it is nothing more than the atavismic tendencies toward the instincts of the wild animal. Domestication has modified these instincts, but will not overcome them until the implements of warfare are laid aside. Even under domestication, the horns therefore still play an important part in the survival of the fittest.

With our four breeds, it was distinctly shown that such animals, as for example, the Ayrshires, which are noted and bred for their fine horns, suffered the most from dehorning. Next come the Shorthorns or Durhams and the Holsteins, the

Digitized by Google

Guernseys and Jerseys coming last. In the case of the two last mentioned breeds, many object to the removal of the well-known crumpled horns, which objection might be sustained. However, in the case of the straighter horns, where any possible danger is involved, it is deemed advisable.

For the operation the principal needs for success are as follows:—

(1.) Two men, who are strong, and yet reasonably quiet with the cows. If the animals are excited, it undoubtedly causes more bleeding, and a greater strain upon the constitution.

(2.) A durable stanchion for the operation.

(3.) A good nose or lead ring. This ring takes their attention more than a halter would; also enables the head to be drawn to one side.

(4.) A pleasant day,—that the animals may be turned loose in the yard after the operation.

(5.) The operating place should be near the stable and yard; but not in them, on account of the blood.

(6.) Have extra handles prepared for the machine, so there will be no delay if one breaks.

(7) It is well to have on hand some bandages, pine tar, and absorbents to check the blood flow, should it continue too long.

(8.) The work should not be attempted in fly time.

Digitized by Google

II. PREVENTING THE GROWTH OF HORNS

BY H. H. LAMSON

Many of the disagreeable features of dehorning may be avoided by preventing the horns of calves from developing.

The horns of cattle consist of two parts of different origin; the outer horny shell is a growth derived from the skin; the inner part or pith consists of bone and is an outgrowth of the skull. See Fig. 3.

At the birth of the calf each of these parts is undeveloped and only exists as a possibility but they at once begin to grow, and in a short time the young horn can be felt as a slight elevation or button.

Bones are covered with a tough, fibrous membrane known as the periosteum, from the inner surface of which new bone is continually being formed upon the surface of the old. It is in this way that growth in size is produced, and it is thus that the bony part of the horn grows.

The horny tissue develops from the skin just as do hoofs and claws in the lower animals and nails in human beings. There is a zone in the skin about the base of the horn known as the matrix, from which new horn-cells are constantly being formed, the older parts being pushed on. If we destroy the periosteum from which the bony part of the horn is formed and the matrix from which the horny part is formed we prevent the further development of the horn. In removing horns which are already more or less developed, as in dehorning mature animals, the cut must be made deep enough to include the matrix or the stump of the horn will continue to grow. It may not be out of place here to remark that there is no danger of cutting into the brain-cavity, as at this point it lies very deeply. The openings frequently

Digitized by Google

seen on removing the horns are only empty spaces with which the frontal bone is honeycombed.

In calves the growing points of the horns are small in extent and can be destroyed with little trouble. This could doubtless be done with a knife but we have had no personal experience

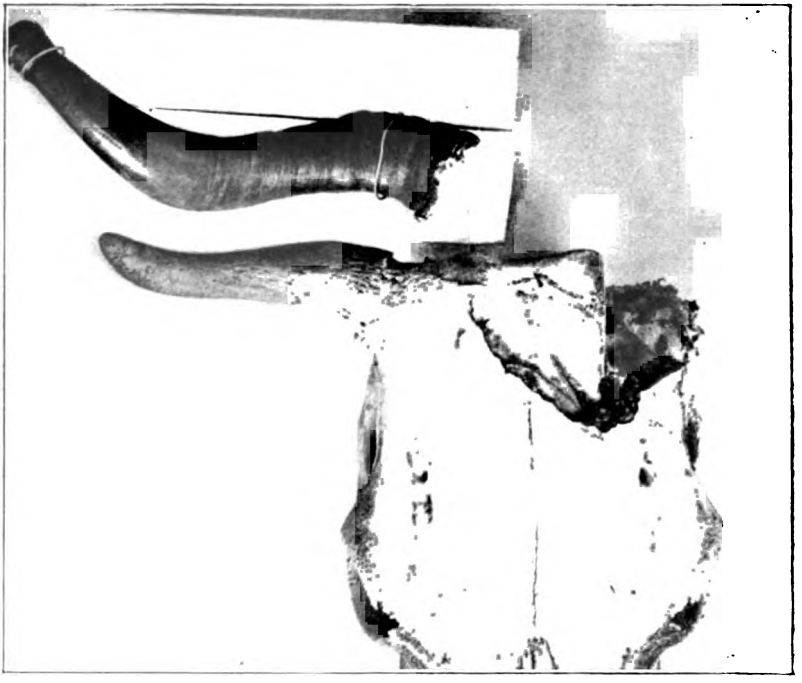


Fig. 3. Skull of a cow, showing the outgrowth of the frontal bone which forms the core or pith of the horn. Above it is the shell or horn tissue proper, which is developed from the skin.

as yet on this point. In our experiments we have made use of caustic potash. Caustic potash, so called, is a pure form of the same substance which constitutes the potash sold in cans for soap-making and cleansing purposes. It is in the form of white sticks, in diameter about the size of an ordinary lead-pencil. As its name indicates it is a powerful caustic, rapidly destroying the skin and other tissues if kept in contact with

Digitized by Google

them. In this property lies its value as a preventive of the growth of horns. When properly applied it destroys the matrix or growing point of the horny tissue and the underlying periosteum from which the bony pith grows.

DIRECTIONS FOR USING CAUSTIC POTASH

The hair should be cut away from the young horn as thoroughly as possible so that the potash may come in intimate contact with the parts to be treated. The oily secretion should be removed from the parts to be touched with the potash, by wiping carefully with a rag or sponge moistened with soapsuds, or water containing a little ammonia. *Parts not to be touched should not be moistened.*

The stick of potash is rolled up in a piece of paper so as to leave one end exposed. The exposed end is dipped in water to moisten it and then rubbed on the button or embryo horn until the skin begins to start, care being taken that the whole of the button and the border or matrix is included in the treatment. In young calves a few days old a surface half an inch or a little more in diameter will cover these parts.

Caustic potash, or caustic soda which answers as well, can be obtained at almost any drug store. When not in use it should be kept in a closely-stoppered vial, one with a rubber stopper preferred, or it will liquefy.

After the calf is two or three days old the sooner the potash is applied, the better.

RESULTS OF USING CAUSTIC POTASH

The following is a record of the calves treated;

	Age Jan. 19, 1898.	Date of treatment.	Age at time of treatment.	Result.
No. 1, Pansy,	12 mos.	Feb. 18, '97	5 wks.	Horns not destroyed, somewhat stunted.
No. 2, Martha,	14 mos.	Feb. 28, '97	14 wks.	Ditto.
No. 3, Helen of Troy,	9 mos.	May 1, '97	1 wk.	Both horns destroyed.
No. 4, Madge of Woodstock,	5 mos., 1 wk.	Aug. 28, '97	16 dys.	"
No. 5, Mischief,	20 wks.	Sept. 6, '97	8 dys.	"
No. 6, Marie,	20 wks.	Sept. 6, '97	5 or 6 dys.	"
No. 7, Maid of Beta,	8 wks.	Dec. 11, '97	14 dys.	"
No. 8, Clara,	7 wks.	Dec. 11, '97,	8 dys.	"

In the cases of Nos. 1 and 2 the treatment was not begun early enough. In the others it was successful.

Digitized by Google

Digitized by Google

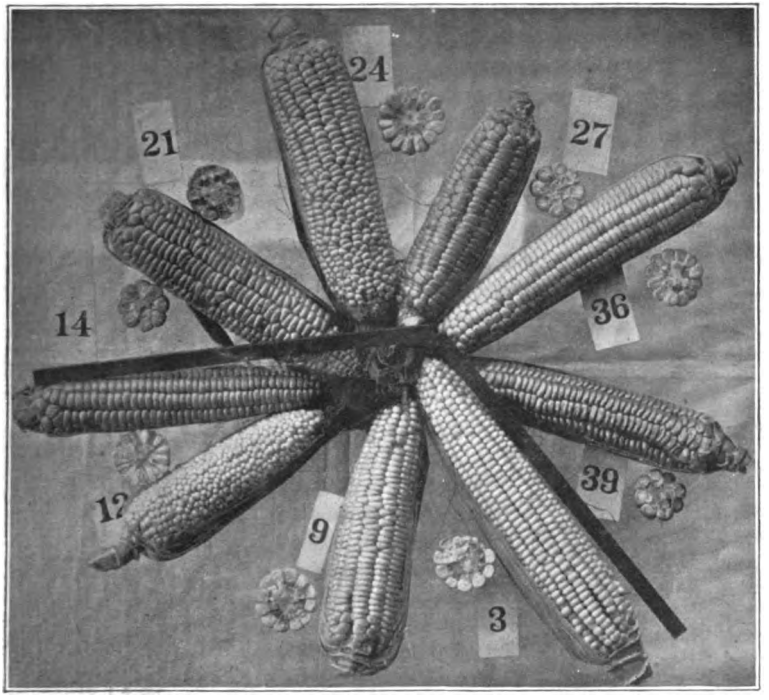
D
Sci 1636.35

Bulletin 51 ✓ March, 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

SWEET CORN FOR NEW HAMPSHIRE



BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1936

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. SC., *Entomologist.*

ASSISTANTS

E. H. FORRISTALL, B. S., *Superintendent of Farm.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
ERNEST J. RIGGS, B. S., *Assistant Horticulturist.*
CLEMENT S. MORRIS, *Clerk.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

SWEET CORN FOR NEW HAMPSHIRE

F. WM. RANE

One hardly realizes the importance of sweet corn as a food for the human family. It is used not only in its immature or green state, but also in canned and dried form. It is much relished as a food, is highly nutritious and cheap. Nearly every garden contains enough green corn for family use, and doubtless it is as easily grown and cared for as anything there produced. Comparatively little is dried as compared with a quarter of a century ago. Canned corn can now be purchased at such reasonable prices that few prepare their own. The popular New England clam-bake also requires a large amount of corn in some sections.

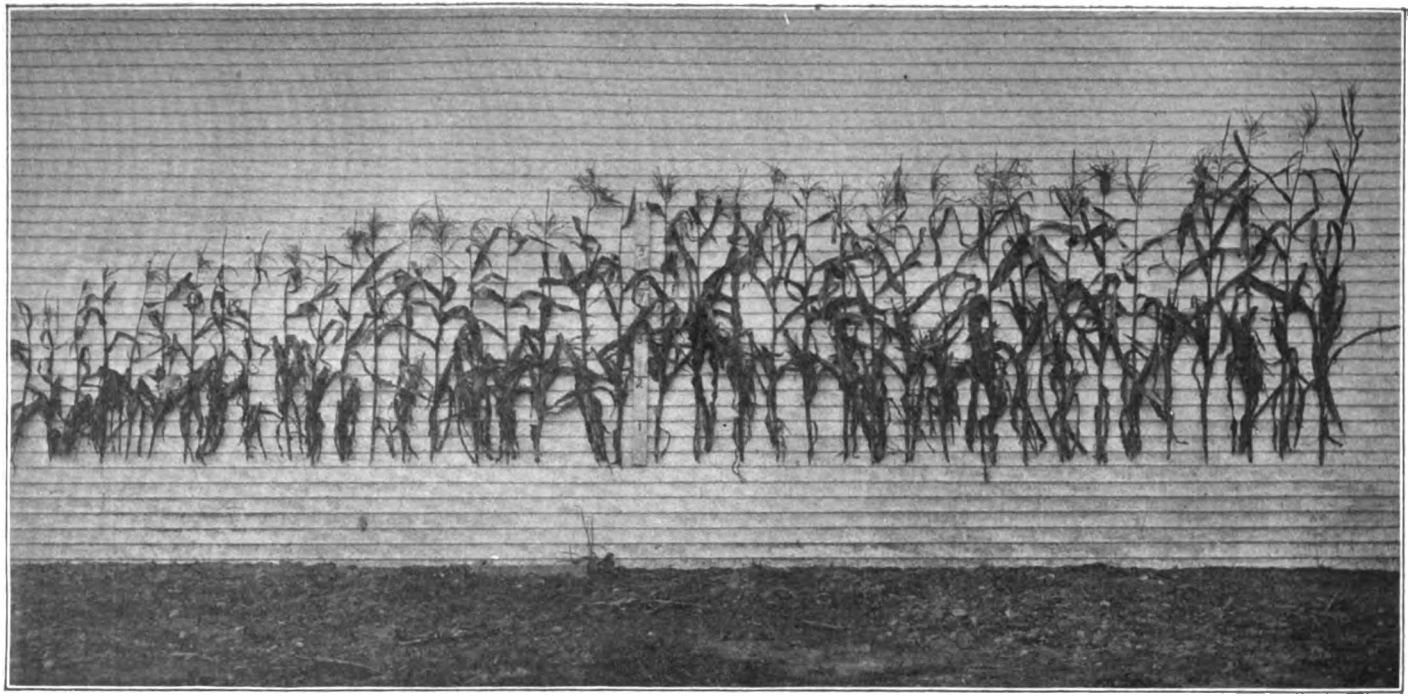
Where a crop like this one has come into such general favor, there naturally follow with it innumerable varieties. It has been our purpose to investigate the subject of sweet corn as adapted to our needs and conditions. Accordingly forty-one of the more important and highly recommended varieties were grown here at the Experiment Station the past year. The season was somewhat backward for most crops, and corn likewise was retarded, although the favorable condition of a well-drained loam gave very satisfactory results. The soil was light and fairly fertile, a heavy crop of grass having been cut the previous year. It was well covered with rather coarse manure before plowing. A small amount of complete commercial fertilizer was used to start the plants. The ground was well pulverized with the cutaway harrow, smoothed and marked in rows three feet apart. All of the varieties, with the exceptions of numbers 39, 40, and 41, were planted on May 22. These three varieties were not planted until May 26.

When the plants appeared, they were thinned in the first

Digitized by Google

hand-hoeing to 9 inches apart in the row. The ground was cultivated by horse-power three times and a second hand-hoeing given when the weeds had started again. This left the ground clean and friable throughout the season. Table 1 has been compiled from the data obtained from this test. The fruit or ear was the principal factor of importance. Photographs were taken at three different times during the fruiting season, which are shown in figures 1, 3, and 4. The numbers indicate a specimen ear of each variety, also a cross section of the same variety; the names being found in table 1. Figure 2 represents a single average stalk of each variety arranged according to height.

Digitized by Google



30, 26, 33, 6, 28, 40, 37, 15, 13, 10, 34, 5, 21, 39, 31, 19, 27, 4, 18, 23, 35, 11, 3, 12, 24, 32, 7, 41, 16, 2, 1, 36, 29, 20, 17, 25, 8, 22, 9.

FIG. 2.—An average stalk of the varieties arranged according to height.

Digitized by Google

TABLE I.—VARIETY TEST OF SWEET CORN.

Number.	Variety.	Edible.	Quality.	Yield.		Average height.	Ears.		Smut.
				Av'ge No. ears per plant.	Doz. per acre.		Length.	No. rows of kernels.	
1	Stonewall's Evergreen	Sept. 20.	Fair.	1.2	1936	9 ft.	9-10 in.	12	None.
2	Henderson	Sept. 10.	Fair.	1.1	1775	7	9-10	12	Very little,
3	Mammoth	Sept. 25.	Fair.	1.1	1775	7.5	10	12-14	None.
4	Moore's Concord	Sept. 14.	Fair.	.7	1129	6	7-8	12-16	None.
5	Perry's Hybrid	Aug. 28.	Poor.	.9	1452	6.5	6	12	Much.
6	Cory's Early	Aug. 17.	Poor.	.8	1291	4.5	5	8	Very much.
7	Stabler's Early	Sept. 4.	Good.	.8	1291	7.5	9	12	None.
8	Roslyn Hybrid		Good.	1.	1613	8	8	12-16	None.
9	Egyptian	Sept. 20.	Good.	.9	1452	9	8	10-14	None.
10	Early Minnesota	Sept. 1.	Good.	.8	1291	5.5	6	8	None.
11	Squantum	Sept. 15.	Good.	.9	1452	7.5	7	12	None.
12	Country Gentleman	Sept. 14.	Good.	.8	1291	7.5	6	Uneven.	Very little.
13	Crosby's Early	Aug. 21.	Good.	1.	1613	4.5	6	12	Some.
14	White Cob	Aug. 17.	Good.	.8	1291	4.5	6	8	Much.
15	First of All	Aug. 24.	Fair.	2.	3226	5.5	6	12	Considerable.
16	Best of All	Sept. 1.	Good.	.9	1452	6	8	8-10	None.
17	Premier	Sept. 4.	Good.	.7	1129	7	7	8-12	None.
18	First Crop	Sept. 1.	Good.	1.6	2581	7	7	8	Little.
19	New England Sweet	Aug. 27.	Good.	.7	1129	6	7	8	Very little.
20	Early Mammoth	Sept. 20.	Good.	1.	1613	8	9	10-12	Very little.
21	Melrose	Aug. 24.	Poor.	.6	968	5.5	6	10-12	Very little.

Digitized by Google

TABLE I.—VARIETY TEST OF SWEET CORN.—*Continued.*

Number.	Variety.	Edible.	Quality.	Yield.		Average height.	Ears.		Smut.
				Av'ge No. ears per plant.	Doz. per acre.		Length.	No. rows of kernels.	
22	Columbus Market	Sept. 25.	Fair.	1.	1613	9.5	9	14–16	None.
23	Hance's Early	Sept. 15.	Ex. good.	1.2	1936	7	8	8	Very little.
24	Zigzag	Sept. 23.	Fair.	1.3	2097	7.5	7	Uneven.	Very little.
25	Improved Ruby	Sept. 25.	Fair.	.9	1452	8.5	9	12	None.
26	Early Fordhook	Aug. 17.	Good.	.8	1291	4.5	5–7	8	Much.
27	New Champion	Sept. 1.	Good.	.7	1129	6	7	8	None.
28	Telephone	Aug. 21.	Poor.	.9	1452	5	5–8	8	Much.
29	Stowell's Evergreen	Sept. 20.	Good.	1.	1613	9.5	9	12–16	None.
30	First of All	Aug. 17.	Good.	.9	1452	4.5	6	8–10	Some.
31	Adams Extra Early	Sept. 1.	Poor.	1.4	2259	7	8	12	None.
32	Cross	Sept. 15.	Good.	.7	1129	7	7	8	Very little.
33	Eastman's Early	Aug. 17.	Good.	1.1	1775	4	5	8	Much.
34	Extra Early Beverly	Aug. 17.	Good.	1.	1613	5	6	10–12	Little.
35	Asylum Sugar	Sept. 4.	Ex. good.	1.1	1775	7	8	10–12	Very little.
36	Triumph Sugar	Sept. 15.	Good.	1.	1613	7.5	8	12	None.
37	Kendel's Early Market	Aug. 25.	Fair.	1.	1613	6	6	8–12	None.
38	Mammoth White Cory	Aug. 17.	Poor.	1.	1613	4.5	4	8–10	Little.
39	Early Orange	Sept. 4.	Good.	.8	1291	6	7	8	Little.
40	Early Essex	Sept. 4.	Good.	1.	1613	7	8	12	Very little.
41	Squantum	Sept. 4.	Good.	.7	1129	5.5	8	10	None.

Digitized by Google

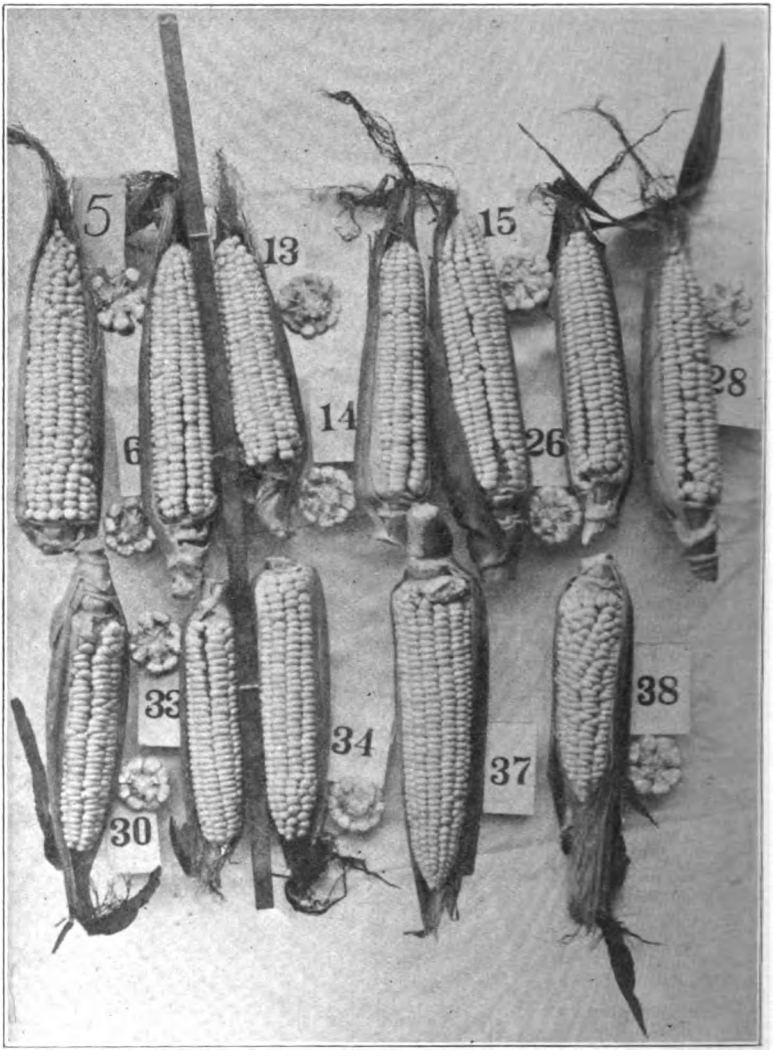


FIG. 3.—Early Varieties.

5. Perry's Hybrid.
6. Cory's Early.
13. Crosby's Early.
14. White Cob.
15. First of All (Buckbee).
26. Early Fordhook.
28. Telephone.
30. First of All (Dreer).
33. Eastman's Early.
34. Extra Early Beverly.
39. Kendel's Early Market.
38. Mammoth White Cob.

Digitized by Google

INFORMATION FROM CANNING FACTORIES

The writer is greatly indebted to two of the largest New England canning factories—H. C. Baxter & Bros., and Stone, Brewster & Co.,—for the following information:

H. C. Baxter & Bros. use Early Crosby sweet corn entirely, and claim it does best when planted about eighteen inches to two feet apart between the rows.

Stone, Brewster & Co. use three grades,—the early, medium, and late. The seed is all the product of their own selection and breeding, which has extended over a period of years. The aim of the company is to select with special reference to obtaining fine quality, heavy ears, and compact and deep-set kernels. Their early and medium varieties are "crosses," while their late variety is the "Country Gentleman." The latter is little planted on account of its late and heavy growth, except on river land and with special reference to using the stalks in the silo. Their early variety is as near "Crosby's Early" as anything on the market, and usually is ready for use by August 20th. Their medium variety is an "Evergreen," like "Crosby's" or "Rice's." The ear is large,—12 to 20 rows—good ears often weighing 1 to 1¼ pounds, husked.

Mr. J. R. Brewster says of this variety: "The fodder is large, and it is the popular variety with the patrons of the factory for profit. This usually gets ready to follow the early variety from September 1st to the close of the season, according to location."

This variety is highly valued by the patrons for ensilage, and they claim it is "utterly impossible" to cure sweet-corn fodder so as to pack away in a barn without its rotting.

The factory rules for planting, as given by Mr. Brewster, are: "Early, rows 2½ ft. and hills 2 ft.; Medium Early, rows 2½ ft. each way; Late, 3 ft. each way." The hills are then thinned to four or five stalks, not over four being allowed to grow in the medium and late varieties. The late variety cannot be depended upon to ripen unless it happens to be a late fall.

Digitized by Google

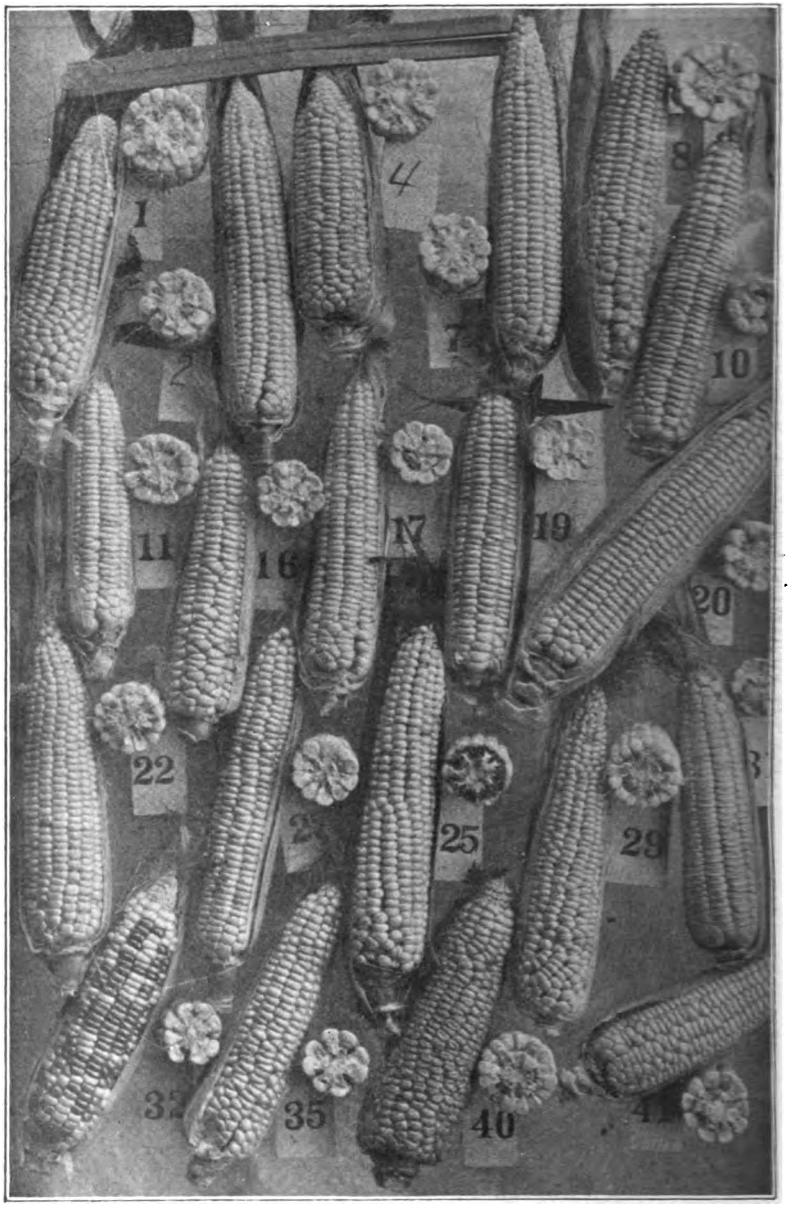


FIG. 4.—An ear and cross section of various varieties. For names see table I.

Digitized by Google

NOTES ON VARIETIES

1. *Stowell's Evergreen;* (Henderson). A late standard variety, stalk 7–9 ft. high, strong, short-jointed; ear, 25 to 30 in. from the ground, white in color, and 8 to 10 in. long; kernels in rows averaging over 12 in number. Large part of the stalks have two ears. This variety is used some for ensilage corn. It matures about right season for that purpose ordinarily.

2. *Henderson;* (Henderson). A stalwart, short-jointed variety. Stalk averages 7 ft. high. Ears 2½ ft. from the ground, and dull white in color. 9 to 10 inches long, tip fairly filled. Ears rather large in diameter.

3. *Mammoth;* (Henderson). Late, large ear, large cob.

4. *Moore's Concord;* (Henderson). Medium early. Some stalks with no ears; few with two. Dull white color.

5. *Perry's Hybrid;* (Henderson). Poor quality and very variable; one ear in twenty smutty. Few suckers of any size. Dull white to reddish color.

6. *Cory's Early;* (Henderson). One of the earliest to mature. Stools. Ripens all fruit at about same time. Considerable smut, 1 ear in 10. Quality poor.

7. *Stabler's Early;* (Henderson). Medium; white variety. Stalk rather long-jointed.

8. *Roslyn Hybrid;* (Henderson). Late white variety. Quality medium.

9. *Egyptian;* (Henderson). Late white variety. Large tall stalks, resembling No. 1 very much. Ears good size and well filled.

10. *Early Minnesota;* (Henderson). An early white, 8-rowed variety. Not as early as many.

11. *Squantum;* (Henderson). White, medium early variety. Ears good size.

12. *Country Gentleman;* (Henderson). A late variety of comparatively recent introduction. As shown in Fig. 1, No. 12, the kernels are very irregular. Ears medium size and good flavor. Has a good reputation.

13. *Crosby's Early;* (Henderson). A standard, early white variety; height 4½ ft. Good quality, fairly productive; small

Digitized by Google

cob; sends up numerous suckers. This variety is quite commonly used in the canning factories of the state.

14. *White Cob;* (Henderson). One of the earliest. Very dark green foliage, 5 ft. high, numerous suckers, good-sized kernels, with small cob; good quality; numerous ears under size.

15. *First of All;* (Buckbee). A new large-eared early variety; ears 8 in. long; cob large and not well filled at tip; kernels about medium size. Stalk 5½ ft.; a heavy yielder; quality fair.

16. *Best of All;* (Buckbee). A new early to second early variety. Ears good size, 8 rowed; quality good. Height 6 ft.

17. *Premium;* (Breck & Sons). Medium early white variety; height 7 ft.; not very productive this season. Kernels 8–10 rows; quality good; 1 in 20 smutted.

18. *First Crop;* (Breck & Sons). An early 8-rowed variety. Many stalks had third ear started. Ears not fully filled at tip, 7–8 in. long. Quality good. Very productive this year.

19. *New England Sweet:* (Ferry). Early 8-rowed variety, originating in New England. Fairly productive; sweet; height 6 ft. The ears harden rapidly, quickly passing the edible stage.

20. *Early Mammoth;* (Weeber & Don). This variety is fully a week earlier than Mammoth (No. 3), and far superior. Ears 12-rowed, large, regular. Quality good. Productive.

21. *Melrose;* (Thorburn). Early 10-12 rowed variety. Light yield, many nubbins, quality poor.

22. *Columbus Market;* (Livingston). A second early variety introduced in 1896. It ripened this season with the late varieties. Good size, ears 14-16 rowed; tip well covered. Fair quality.

23. *Hances Early;* (Livingston). Second early white variety. The cob is long, small, and well filled. It ripens at the time when most corn is used and is very sweet. Productive; a valuable variety.

24. *Zigzag;* (Gregory). Late variety, ripening with Country Gentleman (No. 12). A comparatively new variety. Kernels large; ear of good size; quality fair. Name derived from its uneven rows.

Digitized by Google

25. *Improved Ruby;* (Burpee). A late and novel variety. Both stalks and husks are of a dark red color. Ears large and well filled. Cob dark red. Quality fair.

26. *Early Fordhook;* (Burpee). A new extra early white variety. Ht., four feet, eight inches. A good sized ear, with 8-10 rows, small cob, and large kernels extending to the tip. The rows are regular and present a good appearance. Average yield. Smut, 1 ear in 20. Worthy of trial.

27. *New Champion;* (Johnson & Stokes). Introduced last year. Ht., six feet. Medium sized 8-10 rowed ear. First to second early. Not very productive. Good quality; no smut. The leaves of the plant rusted badly and the corn remained edible only for a short time.

28. *Telephone;* (Salzer). An early variety. Cob medium in size and fairly well filled, although not very closely. Eight rowed and about the average size of the smaller varieties. Ht., five feet; quality poor; color white; average yield.

29. *Stowell's Evergreen;* (Dreer). (Same as No. 1).

30. *First of All;* (Dreer). One week earlier than No. 15 of the same name, also one foot shorter. Av. ht., 4 ft., 6 in. Ear fair size and well covered to the tip. Stools but little. Kernels large and rows mostly regular. Average yield; good quality. But little smut. Worthy of a trial.

31. *Adams Extra Early;* (Dreer). An old standard early variety of poor quality. Its merits are earliness and productiveness. Not a true sweet corn.

32. *Cross;* (from Mr. Powell, Ghent, N. Y.) A novelty of two colors. Ht. 7 ft. Ear 7 in. long; 8-rowed. Second early; good quality.

33. *Eastman's Early;* (Eastman). One of the earliest varieties. Ht. 4 ft., 6 in.; ear 5–6 in. long; cob small and well filled to tip; kernels large; rows regular. Scarcely different in appearance from No. 30. Good quality; above the average yield. Smut 1 ear in 12. Worthy of trial.

34. *Early Beverly;* (Landreth). Fruited with the first; plant 5 ft. tall; ear good size; foliage dark; cob large, well filled; kernels smaller than those of No. 33. Quality good; average yield.

35. *Asylum Sugar;* (Landreth). Medium early white

Digitized by Google

variety. Stalks 7 ft. Ears large, 10–12 rowed, and somewhat irregular. An old variety. Quality, extra sweet; above the average yield. Valuable.

36. *Triumph Sugar;* (Landreth). Late, white variety; stalk, 7 ft., 6 in. Ear, large, 12-rowed. Average yield; old variety. Good quality.

37. *Kendel's Early Market;* (Livingston). A new variety; large ears; comparatively early. Fair quality, average yield. Promising.

38. *Mammoth White Cory;* (Ferry). Although ripening a few ears early, it is not so early as White Cob (No. 14), or Cory's Early (No. 6). Ear rather short; average yield; poor quality.

39. *Early Orange;* (Dunlap). A deep, golden-colored corn. Stalk 6 feet in height, rather slender; not quite up to the average in productiveness; quality good; 8 rowed. A distinct variety.

40. *Early Essex*; (Dunlap). Medium early this year. Good flavor; large ear, well-filled; 12–16 rows, comparatively small cob. Very little smut. Good yield.

41. *Squantum;* (Dunlap). Same as No. 11.

SUMMARY

1. Unless under the most favorable conditions, the late varieties of sweet corn cannot be depended upon for a full crop in New Hampshire.

2. The average date of the first killing frost for New Hampshire for the past fifty years is October 3,—the earliest, August 7, and latest, October 30. The killing frosts of spring are over on the average May 6.*

The dates of the first general heavy and killing frosts for New Hampshire in recent years are: 1885, September 24; 1886, September 21 to 25; 1887, September 26; 1888, September 6 and 7; 1889, September 23; 1890, September 30; 1891, very late; 1892, very late, October; 1893, October 17; 1894, September 11 to 13; 1895, September 14 to 16; 1896, September 23; 1897, September 22.†

* Bailey's Principles of Fruit-Growing, data taken from U. S. Weather Bureau.

† U. S. Weather Bureau, New England section.—J. W. Smith.

Digitized by Google

3. The *Extra Early Varieties* were: Eastman's Early, Extra Early Beverly, Mammoth White Cory, First of All (No. 30), Early Fordhook, Cory's Early, and White Cob. These are named in order of productiveness.

4. The *Early Varieties* were: Crosby's Early, Telephone, Perry's Hybrid, First of All (No. 15), Melrose, Kendel's Early Market, New England Sweet, Adams's Extra Early, Early Essex, Early Minnesota, and Early Orange. Named in order of earliness.

5. Those ripening *Medium Early* were: First Crop, Best of All, New Champion, Asylum Sugar, Squantum, and Moore's Concord.

6. The *Late Varieties* were: Henderson, Country Gentleman, Hance's Early, Triumph Sugar, Cross, Stowell's Evergreen, Early Mammoth, Egyptian, Zigzag, Mammoth, and Columbus Market. Named in order of earliness.

7. The date of planting this season was May 22; and the average number of days required to mature each class was: Extra Early 88, Standard Early 95, Medium Early 102, and Late 110 or more.

8. The following varieties were of *poor quality:* Cory's Early, Perry's Hybrid, Melrose, Telephone, Adams's Extra Early, Mammoth White Cory.

9. For *sweetness* Hance's Early, Squantum, and Asylum Sugar were pronounced.

10. Two *varieties of interest* were: Improved Ruby and Early Orange. The stalks and husks of the former were scarlet and the white kernels set in red hulls. The latter was a deep orange-colored ear, accompanied with a peculiar though not objectionable flavor.

11. A distinct type of extra early sweet corn is found in the four varieties: Eastman's Early, First of All (No. 30), Early Fordhook, and White Cob. These are all very early, sweet, eight rowed, well filled, and of fair size.

12. The Extra Early Beverly was the only extra early 10-12 row variety of good quality.

13. Crosby's Early, although not as early as the earliest by a few days, still remains the standard early variety.

14. The best results from growing sweet corn with commer-

Digitized by Google

cial fertilizers have come in using the following mixture per acre: Dissolved bone-black 370 lbs., muriate of potash 73⅓ lbs., and sulphate of ammonia 73⅓ lbs.*

15. The varieties making the best general showing were: For *Extra Early*, Extra Early Beverly, Eastman's Early, Early Fordhook, First of All (No. 30), and White Cob; for *Standard Early*, Crosby's Early; for *Medium*, Asylum Sugar, First Crop, Early Essex, Squantum; for *Late*, Hance's Early, Triumph Sugar, Stowell's Evergreen, and Country Gentleman.

*New Hampshire Experiment Station, Bulletin No. 10. G. H. Whitcher.

Digitized by Google

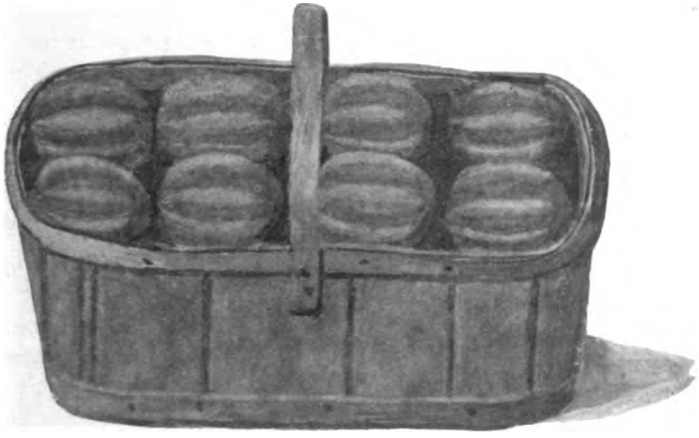
L ARY
OF
PURD E UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
Sci 1636.35

Bulletin 52 **April, 1898**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

GROWING MUSKMELONS IN THE NORTH



BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
NOV 15 1935
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

BULLETINS OF 1898

Bulletin 49—Inspection of Fertilizers. January.
Bulletin 50—Dehorning Cattle. February.
Bulletin 51—Sweet Corn in New Hampshire. March.
Bulletin 52—Growing Muskmelons in the North. April.

Digitized by Google

GROWING MUSKMELONS IN THE NORTH

F. WM. RANE

I. INTRODUCTION

All things considered, there is probably nothing grown in the garden that equals the muskmelon as a delicacy. The fruit has been grown from a very early date, and is supposed to be a native of the hotter parts of Asia, whence it has been introduced all over the world. Writers tell us that in some parts of the Orient, where the melon grows readily in the open air, it forms one of the chief articles of food.[1] In England the melon is very highly prized as a dessert fruit. It is, however, comparatively a luxury, glass houses or frames with artificial heat being necessary for success with it. In this country, owing to our vast range of climatic conditions, it has become, through continuous breeding, adaptable to a wide range of territory.

In the more temperate regions the area devoted to it is so large that in season, such markets as that of Baltimore handle daily trainloads of this fruit. In 1894 the writer visited the market just named. It was about eight o'clock in the morning, and although they had been unloading since daylight, they were still busily engaged. Boats of all sizes,—sloops, cat-boats, pungies, etc.,—103 in number, were lying at the wharves, all heavily laden and waiting their turn for unloading. Across the street fully two hundred teams were also waiting to dispose of their fruit. At the commission houses the melons were sorted and crated in boxes, barrels, or one-half bushel baskets for shipment. The melon is largely grown in New Jersey, Delaware and Maryland, throughout the Ohio and Mississippi val-

[1]Nicholson's Dictionary of Gardening.

Digitized by Google

leys, about Norfolk, and to a greater or less extent by all gardeners about our larger cities.

While the demands of the city markets are met doubtless from the sources named, the average town, village, and country homes are usually without it. It is unfortunate that country grocers and fruit stands should be compelled to send to the commission merchants for this delicacy. There seems to be no reason why it could not be grown and offered for sale by the local gardeners and farmers, or at least enjoyed by the family as the product of the home garden. The melon is none too good for the farmer's own family, and should he be so successful that he has a few to spare, by putting them into the milk-cart, when going to town, or in the case of the gardener, with his other vegetables, there is little doubt but that he would find a ready sale.

We find that comparatively few melons are raised in this state. This is, we believe, partly due to the following reasons:

(1). Comparatively few people understand their culture.
(2). Trouble from insects.
(3). They do not mature early enough.
(4). Insufficient knowledge of varieties.

The selection of varieties seems to be one great point of error. We are usually disappointed in the fruit offered on the menus of hotels; it is almost invariably inedible. Possibly the size of the fruit may have some bearing on the subject. It is quite evident at the fairs that size rather than quality is sought. With the melon, more than any other fruit, increase in size beyond the average is accompanied by a corresponding decrease in flavor. At present, however, the markets are changing in this respect, and there is a growing demand for the smaller varieties, which are sold in half-bushel baskets, about sixteen melons to the basket, as shown on the cover page. The ordinary peach basket was first used, but the market basket with a handle is rapidly displacing it.

Digitized by Google

II. EXPERIENCE WITH MUSKMELONS AT THIS STATION

It is to create, if possible, more interest in this fruit, and thereby to increase its general production, that we give the following data.

The melon was first grown at the station in 1895, from seeds sent out by the United States Department of Agriculture—and with good success. In 1896 the experiments were continued by a test of thirty-six varieties.

During the past season, seventy-two varieties were grown, including those of the previous year. As far as possible the seed was purchased from the introducer, that it might be pure and true to name. There is perhaps no fruit that deteriorates more quickly than the melon when even slightly neglected in seed selection. The seed of all varieties was sown on May 29th. The season was if anything an inferior one for most garden crops, there being comparatively few days at a time when it did not rain.

The soil was a friable clay loam which had been under cultivation the previous year. It was fairly fertile, having been used for a strawberry bed two years before. The muskmelon is not as particular in regard to soil as the watermelon. It will do fairly well on any soil provided it is well-drained and friable. Generally speaking, any soil suited to the cucumber will grow the muskmelon; a light soil is preferable on account of easy cultivation and earliness. It should be of sufficient elevation to guarantee good drainage. The melon asks for soil with only average fertility; too rich a soil induces abundant vines, resulting in poorer quality and lateness of fruit. A soil containing a generous supply of humus or vegetable matter is best for the melon; where this is not already in the soil it can be supplied by plowing under coarse manure or various green manures.

Manuring. The next thing of importance is to have a well-decomposed compost for use in making the hills, where it is

Digitized by Google

thoroughly mixed with the soil. The hills were five by six feet apart, the usual distance, which allows 1,452 hills per acre. The compost is best when mixed a year in advance. It is made by piling up manure, keeping it moist and allowing decomposition to set in. Should hen, sheep, or horse manure be used, it is always best to mix them with soil before stacking. Early in spring, sometime before using, the heap is cut down and shoveled over in order to pulverize it. One or two good shovelfuls per hill is sufficient. Should the compost lack in nitrogenous constituents, as do those named, it is well to add a handful of finely ground bone to each hill, working it well into the mixture of soil and compost. Unleached wood ashes are used with good results by mixing in a similar manner. They do not, however, take the place of the ground bone. Much depends upon the condition of both soil and compost as to the amount of ingredients or manures to be used.

Where commercial fertilizer alone is to be used the following formula has been recommended:[1]

For Nitrogen	(1) 180 to 360 lbs. nitrate of soda; or (2) 150 to 300 lbs. sulphate of ammonia; or (3) 300 to 600 lbs. dried blood.
Phosphoric Acid	(1) 500 to 1,000 lbs, bone meal; or (2) 350 to 700 lbs. dissolved bone, etc.; or (3) 400 to 800 lbs. dissolved rock.
Potash	(1) 130 to 260 lbs. muriate; or (2) 130 to 260 lbs. sulphate; or (3) 1,300 to 2,600 lbs. wood-ashes.

Too much nitrogen is to be avoided as the tendency will be to run to vine rather than fruit. The potash may be applied in the fall, also one-half the phosphoric acid; but the remainder should be applied in spring.

Cultivation. The ground having been in cultivation the previous year, was not plowed until early spring. Fall plowing has many advantages for melon growing, provided the land is not too rolling and therefore liable to wash. By the action of frost the soil becomes friable, insects are to a great degree destroyed, and the land may be worked earlier in the spring.

[1]New York Agricultural Experiment Station, Bulletin No. 94, New Series.

Digitized by Google

When the plowing is done in spring, it should be performed early that the material turned under may have time to at least partially decompose before the roots begin feeding upon them. A heavy soil is plowed and worked more deeply than a lighter one. It should be well pulverized before making the hills.

After planting cultivation was continued both to a good depth and at comparatively frequent intervals. As the plants grew larger, it was lessened, until, when the foliage occupied most of the area, it was stopped altogether. The amount of hand hoeing depends upon the weediness of the ground but should be resorted to at least every week or ten days at first to keep the plants growing. After heavy, dashing storms or in extremely dry weather a slight amount of hoeing loosens up the soil.

Planting and thinning. The soil was marked out, five by six feet, and the hills made at the intersections. When a shovel plow is used, it requires but little work with a hoe to prepare each hole for receiving the compost. The compost is next added and mixed in each hill with about equal parts of the loose soil. This fills the hole level full when well firmed. Each hill is then slightly raised by drawing the loose dirt over the compost to a depth of one and one-half inches.

The seed of all the varieties was planted on May 29th. From fifteen to twenty seeds were placed in each hill to insure against failure in germination, insect troubles, etc. The seed should always be planted sidewise or flat for best results in germination. They were pressed into the soil and covered not over one inch in depth. By firming the soil in the usual way with the back of the hoe, germination is hastened. As soon as the plants were sufficiently established, they were thinned to four plants in the hill.

Pruning or pinching off the end of the vine is often resorted to when the plants are a few feet in length in order to force out the lateral growth which bears the fruit. This is seldom practised, however, by large growers. It is advisable to remove all fruit that sets too late to mature in order to strengthen the others.

Digitized by Google

TABLE 1.—COMPARISON OF VARIETIES OF MUSKMELONS

(Yield calculated from two hills of each variety. Hills 5x8 feet apart.)

Number.	VARIETY.	Date of ripening.	No. of fruits ripened.	Average weight of ripe fruit.	No. of fruits of good size on vines Sept. 27.	Average No. of ripe fruit per acre.
				Lbs.		
1	Apple-shaped Cantaloupe	Sept. 9				
2	Triumph	" 9	4	1.3	4	2904
3	Extra Early Grand Rapids	" 9	6	1.9	9	4356
4	Melrose	" 9	1			726
5	Cannon Ball	" 9	2	2	9	1452
6	Green-fleshed Osage	" 9	2	2.3	11	1452
7	Cosmopolitan	" 9	14	2.5	5	10164
8	Netted Beauty	Failed.				
9	Golden Gem	"				
10	Captain	Sept. 9	7	.9	8	5082
11	No. 88	" 9	7	1.2	9	5082
12	Lone Star	" 9	2	5.1	7	1452
13	Miller's Cream Nutmeg	" 9	3	2.5	16	2178
14	Jersey Belle	" 9	6	1.7	10	4356
15	Mango	" 9	6	2.6		4356
16	Emerald Gem	" 9	6	.4	30	4356
17	Hackensack	" 9	2	3.3	2	1452
18	Newport	" 9	4	.8	12	2904
19	Perfected Delmonico	" 9	3	1 7	13	2178
20	Banquet	" 9	2	3	17	1452
21	Market	" 9	5	3	17	3630
22	Tip-Top	" 9	2	3.8	10	1452
23	Rose Gem	" 9	5	1.3	22	3630
24	Sill's Hybrid	" 9	5	2.3	10	3630
25	Long Island Beauty	" 9	3	3.5	14	2178
26	Six Oaks Cantaloupe	" 9	3	2.2	5	2178
27	New Hybrid	" 9				
28	Triumph	" 9	2	3.9	2	1452
29	Earliest Ripe	" 9	6	1.6	15	4356
30	Cosmopolitan	" 9	5	3	7	3630
31	Ironclad	" 9	4	2.9	7	2904
32	Satisfaction	" 9	5	2.4	10	3630
33	Jenny Lind	" 9	2	.9	22	1452
34	Columbus	" 9	3	2.5	4	2178
35	Pineapple	" 9	2	2	17	1452
36	Seedling—Hybrid Nutmeg	Failed.				
37	Granite State	Sept. 2	7	3.6	11	5082
38	Carmes	" 9	2	3.3	10	1452
39	Shumway's Giant	" 9	4	3.2	3	2904
40	Montreal Nutmeg	" 9	17	3.6	14	12342
41	Early Nutmeg	" 9	6	1.8	14	4356
42	Osage	" 9	3	3	8	2178
43	Bay View	" 9	4	2.9	9	2904
44	Delmonico	" 9	3	3	14	2178
45	Extra Early Hackensack	" 9	6	2.1	7	4356
46	New White Japan	" 9	6	1.8	11	4356
47	Skillman's Fine Netted	" 9	4	2.5	11	2904
48	Christiana	" 9	3	2.5	5	2178
49	Extra Early Cantaloupe	" 9	6	1.9	9	4356
50	Champion Market	" 9	1	2.9	9	726
51	Banana	" 9	3	3.1	4	2178
52	Surprise	" 9	6	2.7	8	4356
53	Chicago Nutmeg	" 9	2	2	8	1452
54	Long Yellow	" 9	9	4.2	7	6534
55	Irondequoit	" 20	1	.5	3	726
56	Casaba	" 9	2	3.7	14	1452
57	Golden-Netted Gem	" 9	6	1	22	4356
58	Bird Cantaloupe	" 9	3	3.1	7	2178
59	Missouri	" 9	3	2.1	10	2178

Digitized by Google

COMPARISON OF VARIETIES OF MUSKMELONS.—*Continued.*

(Yield calculated from two hills of each variety. Hills 5x6 feet apart.)

Number.	Variety	Date of ripening.	No. of fruits ripened.	Average weight of ripe fruit.	No. of fruits of good size on vines Sept. 27.	Average No. of ripe fruit per acre.
				Lbs.		
60	Large White French	Sept. 9	2	3.9	2	1452
61	Netted Nutmeg	" 9	5	2.8	10	3630
62	Large Black Paris	" 9	1	3.5	.....	726
63	Anne Arundel	" 20	2	2.1	1	1452
64	Atlantic City	" 9	3	2.8	13	2178
65	Improved Jenney	" 15	2	3.1	7	1452
66	Acme	" 9	3	1.3	15	2178
67	Citron	" 9	2	3.3	11	1452
68	Ward's Nectar	" 9	2	1.9	15	1452
69	McCotter's Pride	" 9	2	1.7	2	1452
70	Shippers' Delight	" 9	2	1	9	1452
71	Togoodo	" 9	.....	.....	.....	
72	Ivy Gem	" 9	2	2.7	12	1452

Digitized by Google

The first fruit to ripen during the past season was on September 2, just 97 days from planting. The majority took about 103 days. Much depends upon the season as to the time necessary for maturing this crop. For the data of all varieties, see Table I. Photographs were taken to show the characteristics of each variety, which are reproduced in Plates I, II, and III. The last column in the table has been computed to show the average yield of ripe fruit per acre, that it might be compared with other staple crops.

At first glance, when a variety yields but two ripe melons per hill, it appears an unprofitable investment. Calculation proves, however, that this is a yield of 2,904 melons per acre, which at the price of five cents each would give a return of $145.20. From ten to twelve melons is not an uncommon yield per hill, in which case the returns would be of course proportionately larger.

Table II is compiled from the various catalogues, to show the characteristics of each variety grown. Such descriptions as "beautifully netted," "excellently netted," etc., are not especially definite; also the maximum rather than the average in size is likely to be given.

Insects are sometimes very troublesome. Those causing the greatest trouble were the small yellow leaf-beetles—the striped cucumber beetle (*Diabrotica vittata*), yellow with black stripes, and the spotted cucumber beetle (*D. 12-punctata*), yellow with 12 black spots on its back. These insects live over winter under leaves, rubbish, etc., and begin their attack as soon as the first two cotyledonous leaves make their appearance. They are very active, and if the vines are neglected even for a day when the insects are numerous, they will be practically destroyed. By liberally spreading tobacco dust upon and around the plantlets as soon as the insects made their appearance, we were able to keep them off. The dust can be purchased from seedsmen at two dollars per 100 pounds, or five cents per single pound. We have tried nearly everything, and this seems to be the most effective. The other insect liable to be troublesome is the common squash bug. We were, however, troubled very little by it. The best remedy is to hand-pick and destroy it in the cooler portions of the

Digitized by Google

day. If boards are placed about the hills, they will take refuge under them. Its eggs, which are usually laid in clusters on the leaves, are also easily destroyed.

Worms and insects do more or less damage by working into the melon where the fruit comes in contact with the ground. This is easily overcome by placing something under the fruit—small pieces of board, stones, etc.

Fungous diseases are quite prevalent in melon-growing sections. The only one affecting our plantation was the mildew, which was quite serious with some varieties, causing the fruit to become distorted and in some cases worthless. It is found upon both the leaf and fruit. The remedy is to spray with the Bordeaux mixture.

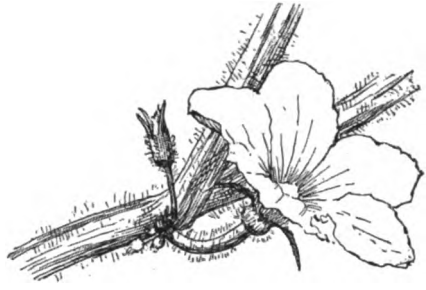


FIG. 1.—Staminate or Male Blossom. (After Bailey.)

The Fertilization of the flowers we believe was much retarded during the past season, which fact doubtless accounts in one way for the comparatively small yield of ripe fruit. The muskmelon depends almost wholly upon insects for the fertilization of its flowers. Owing to the great amount of wet weather and the little sunshine during the time the first flowers were in bloom, these creatures could not assist in fertilization to any marked degree. Plenty of fruit set later in the season on most varieties, as is shown by the number of green fruits in Table I. The muskmelon is monœcious; that is, the sexes are born in separate flowers on the same plant. The first flowers to open are those of the male, which are always more numerous than the females. These flowers are easily distinguished; the female has a melon-like development at the base of the calyx while the male has none. Compare Figures 1 and 2.

Digitized by Google

This season we expect to hand-fertilize the flowers to see if the operation is useful.

Miscellaneous.—The small-sized varieties were more productive than the large. Also, the rule so frequently quoted, "The finer netted, the sweeter the fruit," has too many exceptions to be relied upon. With some varieties a good index as

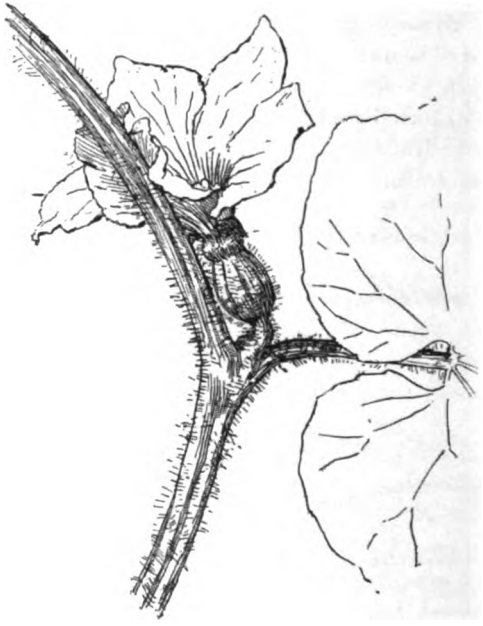


FIG. 2.—Pistillate or Female Blossom. (After Bailey.)

to ripeness is the cracking about the stem; many, however, do not have this tendency.

To ship melons far it is necessary to pick them when at full size, but still green. They are, however, much superior when ripened upon the vines. Early melons are obtained by starting the seed in two- or three-inch pots, or in sods, etc., one plant in a pot; then transplanting into a four-inch pot; from these hardening off in a cold frame; they are then ready for the garden (see Figure 3). We fruited a few varieties in cold frames. The sash was used at first, but was discarded as soon

Digitized by Google

as the outside temperature sufficiently modified. It took 115 days for fruit so handled to ripen.

The writer has also forced the muskmelon in the greenhouse with success, but refers the reader to the more elaborate work

FIG. 3.—Muskmelon Plant ready to Transplant. (After Bailey.)

of Professor Bailey on "Winter Muskmelons," Bulletin 95 of the Cornell University Experiment Station, 1895.

CANTALOUPE

The term cantaloupe when used to designate muskmelons is usually very misleading. A cantaloupe is a melon having a scaly or rough skin, of the warty appearance of the Hubbard

Digitized by Google

TABLE II.—CHARACTERISTICS OF EACH VARIETY FROM CATALOGUES

No.	Color of Flesh.	Shape.	Size.	Outside Characters.
1	Bright salmon.	Apple shape.	Small.	Yellow, mottled with light green spots.
2	Red salmon.	Round.	Large.	Beautifully netted.
3	Salmon.	Round.	Large.	Ribbed and densely netted.
4	Clear light green.	Oval.	About 4 lbs.	Dark green, densely netted, shallow ribs.
5	Green.	Round.	6 in.–8in. diam.	Heavily netted.
6	Pea green.	Egg-shape.	Medium.	Heavily netted and green color.
7	Green.	Round.	Medium.	Heavily netted.
8	Pale green.	Oval.	Medium.	Completely covered with dense netting.
9	Light green.	Round.	About 2 lbs.	Green and thickly netted.
10	Green.	Round.	Small.	Ribbed and thickly netted.
11	Green.	Oblate.	Small.	Has a "button" on blossom end.
12	Salmon.	Oblong.	Large.	Free from ribs and heavily netted.
13	Salmon.	Oblong.	Medium.	Dark-green color and finely netted.
14	Green.	Oblate.	Small.	Deeply ribbed and heavily netted.
16	Salmon.	Oval.	Small.	Emerald-green and smooth.
17	Green.	Oblate.	5-10 lbs.	Deeply ribbed, coarsely netted.
18	Green.	Round.	Small.	Rich golden, evenly netted, ribs shallow.
19	Orange-pink.	Globular.	Large.	Bright yellow, ribs wide, thickly netted.
20	Salmon.	Round.	Medium.	Beautifully netted, without ribs.
21	Green.	Round.	Medium.	Close and strong netting.
22	Yellow.	Round.	Medium.	Thickly netted.
23	Green.	Oval.	Medium.	Slightly ribbed and netted.
24	Salmon.	Round.	Medium.	Ribbed and netted.
25	Green.	Oblate.	Medium.	Densely netted and ribbed.
26	Green.	Round.	Large.	Deeply ribbed, well netted.
28	Red-salmon.	Oval.	10-15 lbs.	Beautifully netted.
29	Green.	Round.	9-11 lbs.	Dark green and heavily netted.
30	Green.	Round.	Large.	Light green, without ribs, silver-gray netting.
31	Deep yellow.	Round.	Medium.	Heavy coarse netting.
32	Yellow.		Large.	Green.
33	Green.	Oblate.	Very small.	Ribbed and covered with shallow netting.
34	Green.	Round.	Medium.	Glossy yellow, ribs shallow, white netting.
35	Light green.	Oblong.	15-16 lbs.	Rich yellow color, skin corrugated.
37		Oblong.	Large.	Deeply ribbed, greenish yellow.
38	Salmon.			Very dark green colored, ribs deep, slightly netted.
39	Light salmon.	Round.	Large.	Yellowish-green.
40	Green.	Oblate.	Very large.	Densely netted, green skin.
41	Green.	Round.	Medium.	
42	Salmon.	Round.	Medium.	Dark green, slightly ribbed, shallow netted.
43	Green.	Oblong.	Large.	Ribbed and densely netted.

Digitized by Google

BLE II.—CHARACTERISTICS OF EACH VARIETY FROM CATALOGUES

Color of Flesh.	Shape.	Size.	Outside Characters.
Orange pink.	Oval.	Large.	Heavily netted.
Green.	Round.	Medium.	Ribbed and coarsely netted.
Greenish white.	Oval.	Medium.	White and smooth.
Green.	Oval.	Medium.	Shallow ribbed and netted.
Yellow.			Green.
Green.	Oblate.	Medium.	Heavily netted and showy.
Light green.	Globular.	4-5 lbs.	Deeply ribbed and heavily netted.
Rich salmon.	Long.	18 in-24 in. long.	Creamy white.
Salmon.	Oval.	Large.	Cream colored.
Green.		Large.	Thickly netted.
Salmon.	Oval.	Large.	Deeply ribbed.
Salmon.	Oval.	Large.	Shallow ribbed and thickly netted.
Green.	Oblong.	Large.	Green, becoming yellow on ripening.
Light green.	Round.	Small.	Excellently netted and regularly ribbed.
Light green.		Very large.	
Green.	Globular.		Wonderfully ribbed and strongly netted.
Yellow.	Oblong.	Large.	Yellow, deeply ribbed, slightly netted.
Green.	Round.		Dark green, netted.
Deep orange.	Oblong.	Very large.	Black, ribs broad and deep, netted.
Green.	Oval.	Large.	Ribs distinct and netted all over.
Green.	Oval.	Large.	Moderately ribbed and heavily netted.
Green.	Round.	Small.	Green.
Green.	Oval.	Large.	Pointed at both ends and strongly netted.
Orange.	Globular.	Large.	Webbed and ribbed.
Green.	Round.	Small.	Finely netted.
Orange red.	Round.	Very large.	Evenly and moderately ribbed, dark green, netted.
Green.	Round.	Large.	Ribbed and heavily netted.
Yellowish green.	Oval.	Large.	Bright, mottled with gray.
Deep salmon.	Round.	Large.	Cream-yellow and deeply ribbed, nearly smooth.

Digitized by Google

squash, and is generally deeply furrowed when ribbed. Various sections of the country have construed the term very differently, some applying it to the yellow-fleshed, and others to the green-fleshed varieties; still others make it applicable to large or small fruit. The term is generally used incorrectly in catalogues. Comparatively few cantaloupes are raised in this country; in European countries they are considered a fruit of delicious flavor.

NOTES ON VARIETIES

The following general notes were taken September 18th; for exterior appearance consult the photographs of each variety in Plates I, II, III:

2. *Triumph* (Burpee). Vines medium strong; fruit round, 5 inches in diameter, netted without ribs. Average productiveness; fair quality.

3. *Grand Rapids* (Burpee). Strong vigorous vines; fruit 7 inches long by 5 inches thick, netted and ribbed, salmon flesh. Well matured and prolific.

5. *Cannon Ball* (Burpee). Fruit round, netted, no ribs, 5 inches in diameter, light green flesh. It cracks open before ripe, is only medium productive and late.

6. *Green-fleshed Osage* (Johnson & Stokes). Fruit black, smooth, medium ribbed. Size 4½ by 5½ inches; prolific, inclined to wartiness; too late this season.

7. *Cosmopolitan* (Burpee). Same as No. 30. Productive.

10. *Captain* (Johnson & Stokes). Fruit round and flat at the ends, ribbed, 4 inches in diameter and 3 inches thick, netted. Vines fairly prolific but not extra strong; some fruit ripen when very small, some also not as flat shaped as others. Flesh green, matures, excellent quality, 9½ on scale of 10.

11. *No. 88* (J. and S.). Vines small but productive. Fruit 3½ by 3½ inches, each melon having a button on the blossom end. Shape round, netted and ribbed; good quality, flesh green.

12. *Lone Star* (J. and S.). The fruit was somewhat variable, size ranging from 5 by 7 to 9 by 7 inches; about one-half were smooth, others netted and ribbed. When ribbed it has a tendency to crack when ripening. Flesh yellow, and very fair quality, 8½. Originated in Texas.

13. *Miller's Cream* (Henderson). This variety is sometimes called Osage, but the above name is preferred to distinguish it from the green-fleshed Osage variety. Fruit 5 by 6 inches, dark green, ribbed. Flesh sweet and salmon color. Prolific but somewhat backward this season.

14. *Jersey Belle* (J. and S.). Fruit netted and ribbed, 4 by 5 inches, broader than long, slightly darkish in color. Flesh green with a whitish tendency, quality good, 8. Productive.

15. *Mango* (Breck & Sons). Fruit matures 5 by 8 inches, ribbed, netted. Leaf three lobed.

Digitized by Google

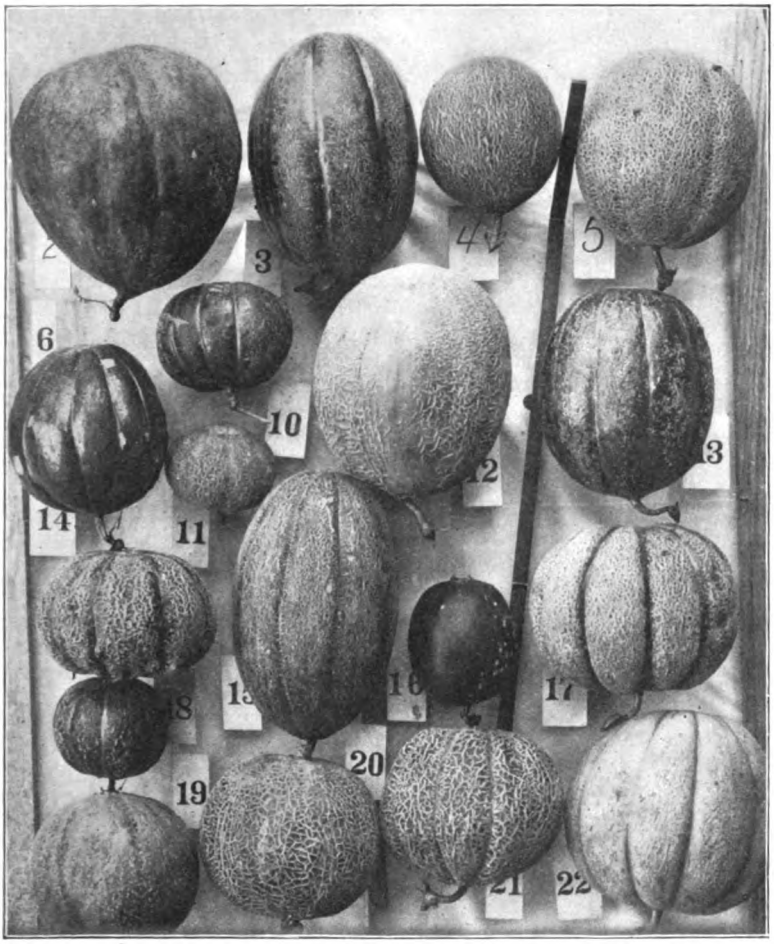


PLATE I.—VARIETIES OF MUSKMELONS.

2. Triumph.
3. Extra Early Grand Rapids.
4. Melrose.
5. Cannon Ball.
6. Green Fleshed Osage.
10. Captain.
11. No. 88.
12. Lone Star.
13. Miller's Cream.
14. Jersey Belle.
15. Mango.
16. Emerald Gem.
17. Hackensack.
18. Newport.
19. Perfected Delmonico.
20. Banquet.
21. Market.
22. Tip Top.

Digitized by Google

16. *Emerald Gem* (Breck & Sons). Vines thrifty, small round, smooth fruit, with a netted tendency; 2½ by 2½ to 3 by 3 inches. Not up to standard for this variety.

17. *Hackensack* (Henderson). Large round, 5 by 7 inches, flattened, ribbed, green flesh. A standard variety, but not so productive as usual this year.

18. *Newport* (Henderson). Small round melons, fairly productive. Slightly dark, ribbed, and netted. Flesh green and of good quality.

19. *Perfected Delmonico* (Henderson). Round, smooth melon 4½ inches in diameter. Flesh orange color and fine quality. This variety had a tendency to crack at the tip end this season which was an objectionable feature.

20. *Banquet* (Henderson). A medium sized melon, averaging 4 by 5 inches the largest being 5½ by 6. The vines were well filled, but the fruit was backward. Without ribs but heavily netted. This variety is quite commonly grown and is considered a standard among salmon-fleshed varieties.

21. *Market* (Livingston). Round, 6 by 6 inches, netted, ribbed. Productive. Same maturity as 20.

22. *Tip Top* (Livingston). About same size as 21, smooth to slightly netted, ribbed, lightish color. Not very prolific this season; quality good 8½, yellow flesh.

23. *Rose Gem* (Livingston). A small melon averages 4 inches in diameter. Netted, slightly ribbed, productive. Flesh dark green, quality good 8½. A fine melon.

24. *Sills Hybrid* (Gregory). Medium round, ribbed, smooth or slightly netted, giving a mottled appearance. Flesh yellow, above the average in quality 9. Productive.

25. *Long Island Beauty* (Gregory). Round, deeply ribbed, heavily netted, Hackensack in type. Fairly productive.

26. *Six Oaks Cantaloupe* (Gregory). Not very thrifty, fruit distorted and warty; flesh green, fine flavor, moderately productive, late. Undesirable in this year's test.

28. *Triumph* (Buckbee). Fruit large, 6½x7½ inches, dark green and very smooth. Flesh salmon color; only moderately productive.

29. *Earliest Ripe* (Salzer). Small melon, 4 inches in diameter, round, netted, slightly ribbed, Emerald Gem type. Not extra early, productive, good quality 9½; desirable.

30. *Cosmopolitan* (Ferry). "Fruit slightly oval, nearly round, without ribs, Color light green, but covered at maturity with dense silver-gray netting." Flesh green. Average size, 5x6 inches. Productive.

31. *Ironclad* (Vaughn). Of somewhat the same shape and size as 30 except being slightly ribbed. Flesh salmon, flavor good 8½; fairly productive.

32. *Satisfaction* (Farquhar). Resembles Miller's Cream but is more round in shape, 6x6 inches. Yellow flesh, good quality 85 to 95; productive.

33. *Jenny Lind* (Dreer). Small green-fleshed melon, globular or a little flattened, ribbed and covered with a shallow netting. Many fruit set but not fully ripe.

34. *Columbus* (Dreer). Smooth light green, a tendency toward nettedness

Digitized by Google

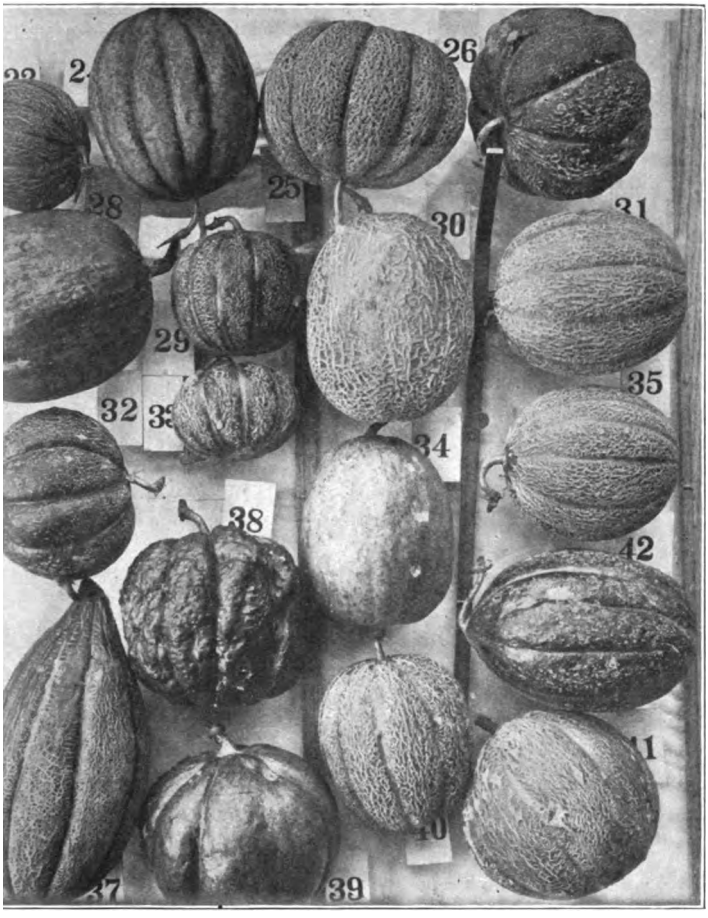


PLATE II.—VARIETIES OF MUSKMELONS.

Rose Gem.
Sill's Hybrid.
Long Island Beauty.
Six Oaks Cantaloupe.
Triumph.
Earliest Ripe.
Cosmopolitan.
Ironclad.
Satisfaction.
33. Jenny Lind.
34. Columbus.
35. Pine Apple.
37. Granite State.
38. Carmes.
39. Shumway's Giant.
40. Montreal Nutmeg.
41. Early Nutmeg.
42. Osage.

Digitized by Google

but many perfectly smooth, 4x5 inches; elongated, a few round. Not many fruit on vine but a large percentage mature.

35. *Pine Apple* (May). Elongated, 4x5 inches, Hackensack type, light green flesh, good flavor 95, fairly productive.

37. *Granite State* (Eastman Seed Co.). Large, long fruit, darkish green, netted and ribbed, size 9 to 11 inches long and 5 to 5½ inches thick. Very productive and sustains its reputation for earliness; it was the first to mature this season. The flavor was not up to the average, which may have been caused by the season. Worthy of trial for a large fruiting variety.

38. *Cormes* (Henderson). Fair size, 5½ inches in diameter, round, black, deep-ribbed, warty. Has a Hubbard squash appearance.

39. *Shumway's Giant* (Gregory). Light color, smooth, round, 6x6 inches, slightly ribbed but not netted. Light salmon flesh. Average productiveness.

40. *Montreal Nutmeg* (Gregory). Large, darkish-nutmeg, globular, 6x6 inches, green-fleshed, uniform in shape, ribbed, netted. The most productive of any this season.

41. *Early Nutmeg* (Gregory). Common nutmeg size, average 5 inches in diameter, green flesh, ribbed, netted, productive.

42. *Osage* (Gregory). Dark green, ribbed, elongated, slightly netted, average size 5½ by 7 inches, fairly productive. A strain of Miller's Cream No. 13.

43. *Bay View* (Gregory). Elongated, 4½x9 inches, slightly ribbed, long striped netting, green flesh, average productiveness.

44. *Delmonico* (Gregory). Large, roundish, 6x7½ inches, elongated, ribbed, large coarse netting. Average productiveness, orange flesh, good flavor.

45. *Extra Early Hackensack* (Gregory). Round and regular nutmeg Hackensack form. Above the average in productiveness.

46. *New White Japan* (Gregory). Smooth, whitish, round to oblong, slightly ribbed, 5x6 inches. Flavor not as good as usual this season. Productive.

47. *Spillman's Fine Netted* (Gregory). Resembles Banquet excepting a slight tendency to produce ribs. Flesh green, quality good 8½, average productiveness.

48. *Christiana* (Gregory). Dark green, fair size, deeply ribbed. Resembles Carmes (No. 38), but is not so much distorted.

49. *Extra Early Cantaloupe* (Gregory). Fruit darkish, slightly elongated, 4 to 5 inches in diameter, ribbed, finely netted, productive, green flesh, flavor good 9.

50. *Champion Market* (Gregory). Fairly good size. Hackensack type, light green flesh, too late this season.

51. *Banana* (Gregory). General banana form, grayish green, smooth surface, flesh yellow, average length this season one foot, poor quality.

52 *Surprise* (Gregory). Round, grayish-green, smooth, slightly ribbed, 6 inches in diameter. Whitish flesh, fair flavor 7. White Japan type.

53. *Chicago Nutmeg* (Gregory). Not a typical nutmeg variety. Dark greenish appearance, very little netted, round, fair size; late, not very productive.

Digitized by Google

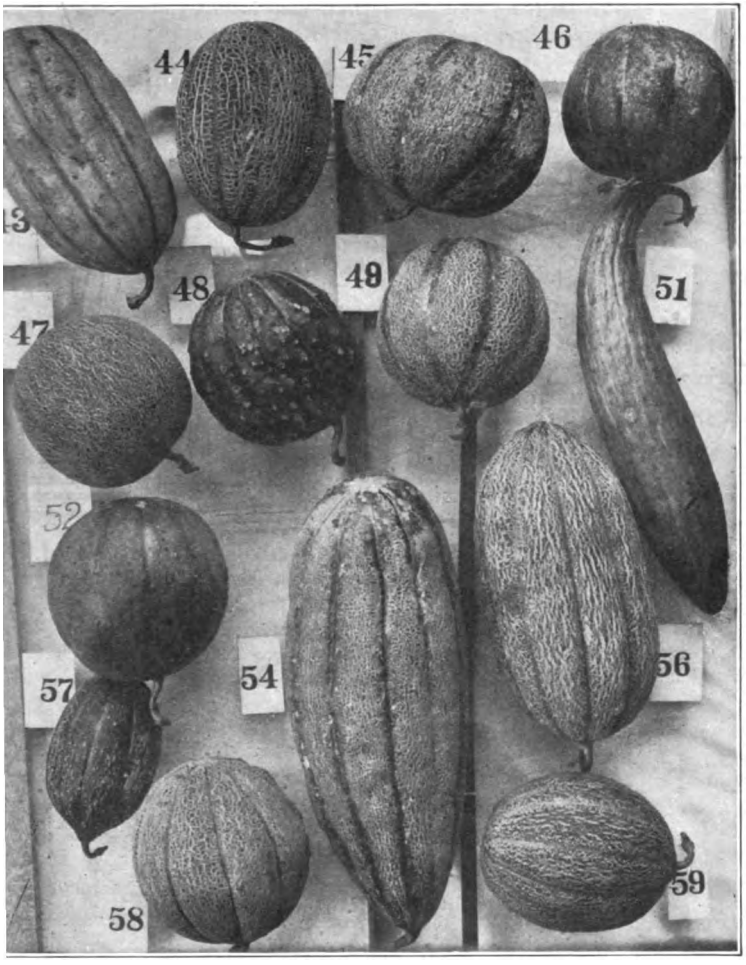


PLATE III.—VARIETIES OF MUSKMELONS.

43. Bay View.
44. Delmonico.
45. Extra Early Hackensack.
46. New White Japan.
47. Skillman's Fine Netted.
48. Christiana.
49. Extra Early Canteloupe.
51. Banana.
52. Surprise.
54. Long Yellow.
56. Casaba.
57. Golden Netted Gem.
58. Bird Cantaloupe.
59. Missouri.

Digitized by Google

54. *Long Yellow* (Gregory). Large fruit 7x13 inches, ribbed, netted, yellow flesh, large cavity, fair flavor 8, very productive. A valuable large variety.

55. *Irondequoit* (Gregory). Smooth dark green variety of the Miller's Cream type. Immature and undesirable here this season.

56. *Casaba* (Gregory). A large, long, green-fleshed variety, 5 by 9 inches, tendency to nettedness, ribbed. Too late for this season.

57. *Golden Netted Gem* (Gregory). Small, round to oblong, slightly netted, ribbed. Above the average in productiveness, green-fleshed.

58. *Bird Cantaloupe* (Gregory). Irregular in form and size. Some smooth and others netted.

59. *Missouri* (Landreth & Sons). Small, round, or globular in form, flattened at each end, ribbed and netted; flesh green, medium productiveness.

60. *Large White French* (Landreth). Oblong melon of large size, 5½ by 9 inches. Color whitish green turning to yellow when ripe; flesh orange. Not very productive this season. Resembles No. 43 but is larger.

61. *Netted Nutmeg* (Landreth). Round, fairly productive; dark green, ribbed, slightly netted, flavor not up to standard. Resembles No. 45, but is more regular in form.

62. *Large Black Paris* (Landreth). Many vines and but few fruit. Ribbed and slightly netted; flesh yellow. Has the appearance of No. 42 with a slightly larger diameter.

63. *Anne Arundel* (Landreth). Large melon, 6 by 8½ inches, ribs very distinct and heavily netted. Flesh green. Not very many fruit to the hill and too late this season.

64. *Atlantic City* (Landreth). Medium in size, pine apple in shape, 5 by 8 inches, dark background netted and ribbed. Flesh green, medium productiveness. Closely resembles No. 59.

65. *Improved Jenny* (Landreth). A typical dark green Hackensack type. Fruit very uniform, 5½ inches in diameter; lightish green flesh of fair quality.

66. *Acme* (Landreth). Dark green, small, oblong, 4 by 5½ inches; peaked at stem end. Flesh green, productive but late this season. Ribbed and netted. Resembles No. 29.

67. *Citron* (Landreth). Large, dark green, ribbed, partly netted and rest smooth, rather distorted, all sizes. Similar to No. 49 but more flat at the ends.

68. *Ward's Nectar* (Gregory). Dark, round, 4½ inches in diameter, ribbed, smooth and one-half netted, fairly productive but few ripened. Flesh green. Resembles No. 32.

69. *McCotter's Pride* (Ferry). Large vines; fruit irregular, roundish, dark green; ribbed, slightly netted, orange red flesh. Not very productive and late this season. Like No. 46, but more netted.

70. *Shipper's Delight* (Johnson & Stokes). Same as No. 11.

71. *Togoodo* (Johnson & Stokes). Good sized, light green, smooth melons. Not sufficiently mature. Plants not very strong.

72. *Ivy Gem* (Johnson & Stokes). Medium size, yellow-fleshed sort; skin

Digitized by Google

smooth to slightly netted, lightish in color, ribbed; globular in form, not very productive this season; good quality. Size and appearance of No. 52, but deeper ribbed.

PARTIAL SUMMARY

1. The reasons for failure with muskmelons seem to be insufficient culture, destructive insects, careless selection of varieties, and lack of fertilization of the blossoms. (Pages 50 and 57.)

2. Well-drained soils containing considerable humus or vegetable matter are the best for muskmelons The lighter soils are preferable. (Page 51.)

3. The best fertilizer is one rich in all the elements of plant food, except stimulating nitrogen. (Page 51.)

4. Frequent cultivation and hand hoeing is of great importance. The growth from the first should be continuous. Once checked, the vines seldom regain their original vigor and productiveness. (Page 52.)

5. Plant sufficient seed so that from three to five good plants can be depended upon. (Page 53.)

6. For the cucumber or squash beetles, dust with tobacco; for the common black squash bug, collect and destroy the eggs and the insects, in the cooler portion of the day. (Page 56.)

7. The varieties grown last season are easily classified into four sizes which are as follows:—

Small Varieties were: Captain, No. 88, Emerald Gem, Newport, Rose Gem, Earliest Ripe, Jenny Lind, Golden-Netted Gem, Shippers' Delight.

Medium-sized Varieties: Melrose, Green-Fleshed Osage, Jersey Belle, Perfected Delmonico, Banquet, Market, Satisfaction, Pineapple, Montreal Nutmeg, Early Nutmeg, New White Japan, Skillman's Fine-Netted, Christiana, Extra Early Cantaloupe, Chicago Nutmeg, Bird Cantaloupe, Missouri, Netted Nutmeg, Acme, Citron, Ward's Nectar, McCotter's Pride, Ivy Gem.

Large Varieties: Extra Early Grand Rapids, Cannon Ball, Miller's Cream Nutmeg, Mango, Hackensack, Tip Top, Sill's Hybird, Long Island Beauty, Six Oaks Cantaloupe, Cosmopolitan, Ironclad, Columbus, Carmes, Osage, Bay View, Delmonico, Extra Early Hackensack, Surprise, Irondequoit, Large Black Paris, Anne Arundel, Atlantic City.

Digitized by Google

Extra Large Varieties: Triumph, Lone Star, Granite State, Shumway's Giant, Banana, Long Yellow, Casaba, Large White French.

8. The *varieties of best flavor*, as shown in the past season's test, were: For *Small*, Captain, No. 88, Newport, Golden Netted-Gem, Earliest Ripe, Rose Gem, Jenny Lind, Shippers' Delight; for *Medium*, Perfected Delmonico, Pineapple, Extra Early Cantaloupe, Satisfaction, Skillman's Fine Netted, Improved Jenney, Jersey Belle, Ivy Gem, Banquet, Market, Netted Nutmeg; for *Large*, Sill's Hybrid, Tip Top, Ironclad, Miller's Cream, Delmonico, Long Island Beauty, Six Oaks Cantaloupe, Surprise; for *Extra Large*, Lone Star, Long Yellow, Triumph.

Digitized by Google

4
Sci 163.35

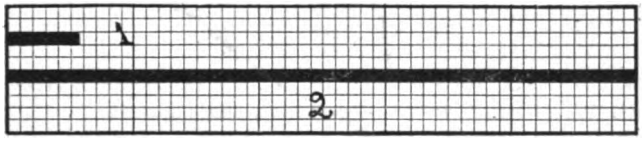
Bulletin 53 ✓ May 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE FARM WATER SUPPLY

BY FRED W. MORSE.



COMPARISON OF NATURAL AND POLLUTED WATERS.

1. Chlorine in normal spring water, less than 0.6 part in 100,000 parts of water.
2. Chlorine in many well waters, 5.0 parts in 100,000 parts of water.

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

Digitized by Google

HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1936

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director*.
FRED W. MORSE, B. S., *Vice-Director and Chemist*.
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist*.
CHARLES H. PETTEE, A. M., C. E., *Meteorologist*.
HERBERT H. LAMSON, M. D., *Bacteriologist*.
CLARENCE M. WEED, D. Sc., *Entomologist*.

BULLETINS OF 1898

Bulletin 49—Inspection of Fertilizers. January.
Bulletin 50—Dehorning Cattle. February.
Bulletin 51—Sweet Corn in New Hampshire. March.
Bulletin 52—Growing Muskmelons in the North. April.
Bulletin 53—The Farm Water Supply. May.

Digitized by Google

THE FARM WATER SUPPLY

BY FRED W. MORSE

Since the experiment station has been in its present location, it has often been asked to analyze water, and numerous samples from wells and springs have consequently been examined to find out their sanitary condition.[1]

This bulletin has been prepared in order to present to the farmers of the state some facts observed in the course of the work that should be of interest to the occupants of every farm, especially in those sections of the state which attract summer visitors.

New Hampshire has been provided by Nature with an abundant and pure supply of water. The springs and streams of the state that are beyond the reach of the wastes from its population, furnish water which is almost always pure and soft, because most of our rocks are made up of the minerals, quartz, feldspar, mica and hornblende, which dissolve very slowly, even in the strong acids of the chemical laboratory. Limestone, which is more easily dissolved, and is usually the cause of "hard" water, occurs in only a few localities along the Connecticut river. According to Professor Hitchcock,[2] the limestone area includes portions of Stewartstown and Colebrook; isolated ridges in Littleton, Lisbon, Lyman, Orford and Lyme; most of the townships of Plainfield and Cornish, a strip through Claremont and a hill in Charlestown.

The source of the water which flows in streams, lies quietly in lakes, bubbles forth in springs or stands in wells, is the rain and snow. Part of the rainfall on any area, runs off the sloping surface to the brooks and ponds, some is evaporated by the wind and sun, and the rest soaks into the soil, which at some distance below the surface is thoroughly saturated. The

[1] At first the work was done free of charge; but as it has increased and required a large amount of time on the part of the chemical laboratory, while the government appropriation was not intended for such sanitary investigations, it has become necessary *to charge a fee sufficient to cover the cost to the station for time and material.*

[2] Geology of New Hampshire.

Digitized by Google

upper level of the standing ground water is commonly called the water-table, and is somewhat higher than the surface of nearby ponds or quiet streams, the height varying with the shape of the land, the kind of soil, and the dryness of the season.

The proportion of matter, which the ground water will have in solution, depends upon the quantity of soluble substances with which it came in contact during its passage from the clouds, through the air and soil, and the amount of dissolved material that plant-roots will absorb as the water percolates among them.

This soluble matter consists of both organic and mineral substances and is determined by evaporating a measured quantity of water to absolute dryness and weighing the residue. In waters from localities affording no opportunity for pollution from dwellings or barn-yards, we have found less than 10 parts of solid residue from 100,000 parts of water, while in waters from polluted sources we have almost always found a much larger amount. By carefully burning the total residue, the organic matter is destroyed and the mineral matter determined by weighing the fixed residue. Following are some results which substantiate what has been said about the naturally insoluble nature of New Hampshire rocks:

RESIDUES FROM UNPOLLUTED GROUND WATERS. PARTS IN 100,000

Locality.	Total solid residue.	Fixed residue.	Locality.	Total solid residue.	Fixed residue.
Durham.....	8.20	5.40	Hillsborough ..	6.20	4.40
Durham.....	9.80	4.80	Meredith.....	5.60	4.20
Durham....	9.40	.....	Wakefield.....	4.20	2.20
Newmarket.....	5.80	2.90	Tamworth.....	5.00	3.20
Northwood	6.80	.....	Ashland.....	4.40	.....

Similar results have been obtained in Massachusetts. According to the Report of the Massachusetts State Board of Health for 1891, page 356, twenty-two unpolluted springs yielded water with less than ten parts of solid matter dissolved in 100,000 parts of water.

Digitized by Google

More important than the amount of matter dissolved in the water, is the composition of that matter, a study of which is necessary in order to judge the source of the substances in solution and whether a water is dangerous or not. The best evidence of the origin of the matter dissolved in water, is obtained by determining the amount of chlorine present. This element is one of the two that form common salt and is almost invariably present in a natural ground water; but in only slight traces, except near the sea-coast where the spray from the ocean is taken up bodily by the wind and borne inland. The proximity of cultivated fields must modify the amount of chlorine naturally present in a spring-water, owing to the application of fertilizers.

The lowest results obtained in waters from apparently unpolluted springs are given in the table. It will be noticed that the figures decrease rapidly as the distances of the localities from the coast increase. These figures are similar to those obtained in Massachusetts from normal waters.[1]

CHLORINE IN UNPOLLUTED GROUND WATERS. PARTS IN 100,000.

Locality.	Chlorine.	Locality.	Chlorine.
Durham, Strafford Co.....	0.63	Northwood, Rockl'gh'm Co	0.20
Durham, Strafford Co.....	0.58	Epsom, Merrimack Co.....	0.21
Durham, Strafford Co.....	0.41	Alexandria, Grafton Co...	0.14
Newmarket, Rockingh'm Co	0.49	Lempster, Sullivan Co.....	0.11
Barrington, Strafford Co....	0.39	Tamworth, Carroll Co.....	0.10

To judge the healthfulness of a water after knowing something about the origin of its soluble constituents, the most stress is laid upon the relative quantities of four different compounds of nitrogen, an element occurring in all animal and vegetable tissues, as well as forming four-fifths of the atmosphere. It occurs in water in the form of ammonia, soluble organic matter and two classes of compounds, called respectively nitrites and nitrates.

The ammonia in unpolluted spring-water is due mainly to

[1]Rept. Mass. State Board of Health, 1890.

Digitized by Google

the rain, which washes the atmosphere free of this gaseous substance, that escapes into it from every fire and every piece of decaying animal or vegetable substance. The ammonia present in water is usually spoken of as free ammonia in order to distinguish it from ammonia which the chemist obtains from the nitrogen in the soluble organic matter by means of suitable chemicals and calls albuminoid ammonia. Ammonia and soluble organic matter containing nitrogen are rapidly changed in the soil by certain micro-organisms into nitrites and nitrates. These latter compounds, especially nitrites, are also formed in the atmosphere by electrical discharges and therefore occur in rain especially after or during thunder showers. Nitrites and nitrates are very necessary to the life of plants, however, and consequently, under natural conditions of soil and moisture, they will be absorbed by plant-roots as fast as formed. Hence unpolluted springs show no nitrites nor nitrates and only minute quantities of free and albuminoid ammonia. Heavily manured fields in the vicinity of a spring may cause the presence of nitrates and nitrites as well as an increase of chlorine in the water, because there is often a larger supply of them than the crops can handle, and they are easily leached from the upper layers of soil beyond the reach of plant-roots. Leaves or sawdust not uncommonly to be found in springs, are pretty sure to increase the amount of albuminoid ammonia above what it would be if the spring were clean. The following table will better explain these variations.

NITROGENOUS MATTER IN GOOD GROUND WATERS. PARTS IN 100,000.

Locality.	Free Ammonia.	Albuminoid Ammonia.	Chlorine	Nitrogen in Nitrites.	Nitrogen in Nitrates.	Solid Residue.
Fremont[1]	.0014	.0082	.34	.0000	.000	5.40
Durham[2]	.0028	.0065	.68	.0004	.025	*15.00
Northwood[3]	.0005	.0158	.20	.0000	.000	6.80

* Walls of spring are of brick and cement, causing lime in water and high solid residue.

[1] Free from contamination. Residue did not blacken when burned.

[2] Spring near a corn-field. College farm.

[3] Spring contained leaves. Residue blackened when burned, showing presence of organic matter.

Digitized by Google

Water from very deep wells which get their supply from strata of soil below the influence of local surface impurities, usually differ somewhat in composition from the waters of unpolluted springs, more particularly in the amounts of mineral matter and chlorine. In the table which includes a few such wells, it will be noticed that the solid residue is much higher in proportion, than it is in the spring-waters; yet the insolubility of our granite rocks is still manifest, because similar depths in other parts of our country yield water containing from four to ten times as much soluble mineral matter.

CONSTITUENTS OF WATERS FROM DEEP WELLS. PARTS IN 100,000.

Locality.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen in Nitrites.	Nitrogen in Nitrates.	Solid Residue.
Newmarket[4]	.0012	.0024	5.12	.0002	.....	22.5*
Newmarket[5]	.0005	.0005	0.59	.0000	.....	16.2
Dover[6]	.0028	.0080	0.67	.0000	.085	19.4*
Farmington[7]	.0094	.0024	0.62	.0000	.001	12.2†

* Solid residue contained much lime.

† Solid residue contained much iron. Water was opalescent with iron compounds.

[4] Well dug through 5 feet of sand, then through 28 feet of soft clay. Thence an iron pipe driven down 59 feet, finally striking a thin layer of gravel over solid rock. Bottom of pipe reaches a depth 15 feet below the bed of the river, which at high tide runs within 50 feet of the well. Well overflows continuously at a level 5 feet above high tide.

[5] Well 108 feet in depth, first 30 feet in sand, then 68 feet in clay, remainder in gravel. Water rises to within 10 feet of surface of ground.

[6] Well 170 feet in depth, drilled down from the bottom of an old well through 140 feet of rock.

[7] Well 128 feet in depth, drilled in a ledge.

A few samples of water have been received that were seriously contaminated with iron, though otherwise good. Such water is usually clear when freshly drawn from the well, but on exposure to the air, it soon becomes opalescent, due to the changes taking place in the iron salts by which insoluble compounds are formed, sometimes ending in deposits of particles of iron rust. Such water is more unpleasant than injurious, being especially unsuitable for laundry use. The iron may, and usually does, come from iron salts in the rocks; but in one case it appeared to be due to an old chain-pump. The former cases cannot be remedied, but the latter could be.

Digitized by Google

Having been provided by nature with the best of ground water, what kind does the average farm household use for drinking and other domestic purposes? An examination of many farms will show that the well has been located with more regard for convenience than health. A common situation is within fifty feet of a sink-drain, a privy-vault, or a barn-yard, and sometimes the well is surrounded by all three. Usually a curb or embankment prevents any surface-wash from entering the well; but it does not appear to be borne in mind that a large part of the rain-fall soaks into the earth, carrying with it the soluble constituents of animal and kitchen wastes with which it came in contact on the surface, sooner or later to reach the well.

The waters from such wells have almost always been found to leave much larger amounts of solid residue than those from unpolluted springs, and contain a higher proportion of chlorine, because salt is abundant in all animal excretions and kitchen slops. The waters are usually hard, since lime is also an important constituent of animal wastes. High chlorine at a distance from the ocean, may be considered in this state, a sure indication of sewage pollution, and in most sections hard water should be regarded with suspicion. The four forms of nitrogen compounds in these waters give a larger aggregate than in pure spring-waters, but the relative proportions of free ammonia, albuminoid ammonia, nitrites and nitrates, vary widely in different samples. They all come from animal and vegetable matter dissolved in the water, and show the stages of decomposition which such matter has reached. These stages depend upon the character of the soil and the amount of contamination.

Free and albuminoid ammonias are usually high where the soil either permits free pollution or hinders the oxidation of the organic matter. Nitrates are high when the soil favors the rapid oxidation of the organic matter. Consequently, waters containing much free and albuminoid ammonia arising from sewage, would be dangerous; but if the nitrogen were present only in the form of nitrates, the sewage would have been oxidized to harmless mineral matter. Nitrites being an intermediate stage in the destruction of organic matter are looked upon as suspicious constituents of water if not dangerous.

Digitized by Google

The table shows the results obtained in the examination of some typical farm wells, selected from the large number of analyses made during the past five years. The last three numbers are the only ones of their class from which samples have been received; but they show clearly what can be accomplished by intelligent care of the well's surroundings.

CONSTITUENTS OF WATERS FROM FARM WELLS. PARTS IN 100,000.

Locality.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen in Nitrites.	Nitrogen in Nitrates.	Solid Residue.	Remarks.
Dover[8]	.0018	.0204	5.08	.0260	.714	37.00	Bad.
Northwood[9]	.0192	.0152	7. 8	.0005	.060	47.80	Bad.
Weare[10]	.2000	.0344	6.22	.0570	2 000	53.40	Bad.
Lee[11]	.0032	.0206	1.20	.0150	.060	10.00	Bad.
Durham[12]	.0024	.0104	2.60	.0000	.000	21.80	Suspicious.
Milford[13]	.0052	.0090	4.08	.0008	.001	18.00	Suspicious.
Raymond[14]	.0052	.0084	4.10	.0016	.400	23.20	Suspicious.
Alstead[15]	.0000	.0038	7.00	.0012	2 250	49.20	Thoroughly oxidized.
Peterborough[16]	.0025	.0115	.68	.0000	.400	8.00	Probably safe.
Milford[17]	.0014	.0028	.84	.0000	.000	9.40	Good.

[8] Well situated near the door of house. Curb of well and embankment to cellar are higher than surrounding ground. Water pumped from well to clear the pipe stands in hollow between curb and embankment until it soaks into ground or evaporates. Much of this water probably again reaches the well.

[9] Well, 13 feet in depth, 80 feet to privy vault, 80 feet to sink-drain, 70 feet to barn-yard. Soil, a gravelly loam, overlying gravel, blue hard-pan, sand and ledge.

[10] Well, 18 feet in depth, 50 feet to barn-yard.

[11] Well, 15 feet in depth, 45 feet to barn-cellar, 75 feet to sink drain.

[12] Well, 20 feet in depth, 60 feet to vault, 40 feet to sink drain, 60 feet to barn-yard. Soil, a stiff clay.

[13] Well, 20 feet in depth, 50 feet to vault, 30 feet to sink drain, 50 feet to barn-yard.

[14] Well, 14 feet in depth, 60 feet to vault, 60 feet to sink drain, 75 feet to barn-yard containing a pool of liquid manure. Soil, a gravelly loam with sandy subsoil.

[15] Well, 24 feet in depth, formerly within 60 feet of vault, 30 feet of sink drain, and 100 feet of barn-yard. All these surroundings have now been removed and the ground scraped clean. The analysis shows a heavy contamination in the past; but now thoroughly transformed into harmless mineral salts.

[16] Well, 20 feet in depth, situated between house and shed. Sink drain and vault have been removed from proximity to well.

[17] Well, 10 feet in depth, 56 feet to vault, which is water-tight; 100 feet to sink drain, which flows over surface of ground; 16 feet from corner of barn-cellar, which is cemented on the bottom and kept dry. A good example of thorough care.

Digitized by Google

The question may be asked, What is the specific effect on the human system of these substances which occur in drinking water? It is the opinion of several physicians interrogated, that many cases of general debility and of bowel troubles may be ascribed to water polluted by sewage. The latter complaints are especially apt to occur in individuals who are newly subjected to such water, after being accustomed to good soft water. This fact makes especially emphatic the necessity of pure water on farms that accommodate summer visitors from the cities.

The greatest danger in the use of sewage polluted water, is the possible presence of the bacteria which cause typhoid fever. These germs of disease cannot exist for any length of time in our good spring waters, because there is too little matter for them to feed on; but polluted waters furnish the necessary conditions for their maintenance in the products of decomposing organic matter, and they may live in such water several weeks, ready to poison some person obliged to drink it.

Of course, all waters showing high proportions of chlorine and ammonia do not contain disease germs; but the figures are danger-signals not to be disregarded.

It is commonly assumed that the soil acts as a filter on water and removes all dangerous matter as the water passes through it, but repeated trials by sanitary experts have shown that neither earth nor any other common filtering material will remove disease germs from water unless there is a thorough destruction of the soluble organic matter, thus depriving them of food.

To make more emphatic the dangerous character of typhoid-fever germs, a few facts are given from the Report of the Massachusetts State Board of Health for 1892, and from Mason's *Water Supply*.

Typhoid fever is produced by a bacillus that is invariably found in the feces of victims of the disease. This bacillus has been found to live three weeks in river water, three months in the stools of a typhoid patient, over three months in ice, and five and one half months in soil. Sunlight will kill the germs; but the sun's rays do not penetrate the earth nor into the recesses of privy-vaults and cess-pools.

Digitized by Google

In many instances, reasonable care of the surroundings of the well would remove all danger from disease by the pollution of the water. Privy-vaults should be made water-tight, well ventilated, and frequently supplied with dry earth. Nature has provided an abundance of micro-organisms in feces and in soil that with plenty of air and little moisture will rapidly change all soluble organic matter into harmless gases to be dissipated in the atmosphere. The sink-drain should be carried as far as practicable from the house to a lower level than the bottom of the well if possible, and discharged upon the surface of the ground. The sun will help disinfect the sewage and if rank plants are encouraged to grow on the spot during the summer, there will be little percolation to the ground-water.

A cess-pool should never be used in the vicinity of any well or spring; a pit in the earth, from which the water, saturated with soluble filth, slowly seeps away, furnishes practically no chance for the purification by the soil organisms, because they act weakly or not at all, at depths of two to three yards below the surface of the earth.

The economical handling of manure and garbage by composting in cemented cellars or sheds, where leachings cannot escape, will prove both pecuniarily and healthfully superior to the careless treatment usually given those substances.

On many farms a supply of water can be obtained from a source remote from any danger of contamination, and the substitution of such a source for the farm-well is the best means of receiving good water. When a spring is lower than the farm-buildings, careful attention should be paid to the direction in which the drainage from them would naturally flow. A pond or stream is seldom suitable for a family supply because its drainage-basin is usually beyond the control of any single farm. A tight cistern connected with clean roofs furnishes a safe source of supply if the cistern is kept clean.

For more details of the disposal of sewage on the farm and the care of a water supply, the reader is referred to *Farmers' Bulletin, No. 43, Sewage Disposal on the Farm*, which may be obtained by addressing the Secretary of Agriculture, Washington, D. C.

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 54 June 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE WINTER FOOD OF THE CHICKADEE

THE CHICKADEE OR BLACK-CAPPED TITMOUSE.

BY CLARENCE M. WEED

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE. A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director*.
FRED W. MORSE, B. S., *Vice-Director and Chemist*.
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist*.
HERBERT H. LAMSON, M. D., *Bacteriologist*.
CLARENCE M. WEED, D. Sc., *Entomologist*.

ASSISTANTS

ELWIN H. FORRISTALL, B. S., *Superintendent of Farm*.
CHARLES D. HOWARD, B. S., *Assistant Chemist*.
ERNEST J. RIGGS, B. S., *Assistant Horticulturist*.
WILLIAM F. FISKE, *Assistant Entomologist*.
CLEMENT S. MORRIS, *Clerk*.

BULLETINS OF 1898

Bulletin 49—Inspection of Fertilizers. January.
Bulletin 50—Dehorning Cattle. February.
Bulletin 51—Sweet Corn in New Hampshire. March.
Bulletin 52—Growing Muskmelons in the North. April.
Bulletin 53—The Farm Water Supply. May.
Bulletin 54—The Winter Food of the Chickadee. June.

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

THE WINTER FOOD OF THE CHICKADEE

BY CLARENCE M. WEED

FIG. 1. Eggs of Apple Aphis.

Throughout New England, the Chickadee, or Black Capped Tit-mouse, *Parus atricapillus*, is one of the most abundant winter birds. It is commonly distributed over a wide area, in which it may be seen day after day, busily searching the twigs and branches of trees and shrubs. In order to determine more definitely the economic status of the species, the writer recently undertook a study of its winter food, the results of which are recorded in this bulletin. In the investigations I have been indebted to Mr. Ned Dearborn for many specimens, and have been aided in various ways by my assistant, Mr. W. F. Fiske. I am also under obligations to Dr. L. O. Howard of the U. S. Department of Agriculture, for the determination of some of the food elements.

The results as a whole show that more than half of the food of the chickadee during the winter months consists of insects, a very large proportion of these being taken in the form of eggs. About five per cent. of the stomach contents consisted of spiders or their eggs. Vegetation of various sorts made up a little less than a quarter of the food, two-thirds of which, however, consisted of buds and bud scales that were believed to have been accidentally introduced along with plant-lice eggs. These eggs made up more than one-fifth of the entire food, and formed the most remarkable element of the bill of fare. It seems to me evident that a large proportion of the bud scales are accidentally introduced into the stomachs of the birds, because most of the aphid eggs are taken from the crev-

Digitized by Google

ices beside the buds of deciduous trees and shrubs, and so it must commonly happen that bud scales are pecked away and swallowed with the eggs.

FIG. 2. Plant Lice Eggs on Twig of Birch (These eggs are eaten by Chickadees.)

This destruction of the myriad eggs of plant-lice which infest fruit, shade, and forest trees is probably the most important service which the chickadee renders during its winter residence. As indicated in the record below, more than 450 eggs sometimes occur as the food of one bird in a single day. On the supposition that one hundred were eaten daily by each of a flock of ten chickadees, there would be destroyed 1,000 a day, or 100,000 during the days of winter, a number which I believe to be far below the real condition, could we determine it precisely.

The most remarkable fact regarding the life history of plant-lice is their power of multiplication. Each egg hatches in spring into what is known as a viviparous female aphid, that is, a form which gives birth to living young by a process similar to the method of reproduction in some of the lowest animals, known as budding. This process begins about two weeks after hatching, each aphid giving birth to a large number of young, that in turn soon become mature and give birth to others. Consequently multiplication goes on in a constantly increasing geometrical ratio, that leads to the production of enormous numbers of the pests. Were it not for the numerous checks upon these insects found under natural conditions, they would overrun plants everywhere and render agriculture futile. In the window-garden and the greenhouse, where these checks are not always at work, the aphides often destroy plants unless some artificial remedy is employed against them. Even on crops out of doors the injury due to their presence is frequently great, and were it not for the destruction of their eggs by chickadees and other enemies, there can be no doubt that the damage would be vastly greater.

Digitized by Google

On those trees whose leaves drop off in autumn the eggs of plant-lice are commonly deposited in the crevices about the buds. The eggs of the common apple aphis are indicated as black specks about the buds in Fig. 1; those of an abundant species on birch are shown in Fig. 2; while Fig. 3 illustrates the eggs of a species that lays its eggs in great numbers upon the bark of willow branches. Although it is impossible to determine precisely the different species of plant-lice from their eggs, there was reason to believe that each of the species shown in these three figures had been eaten freely by the chickadees examined.

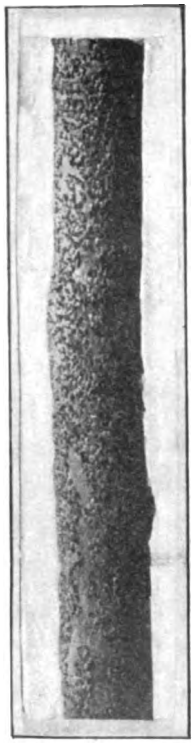


FIG. 3. Eggs of Plant-lice on Bark of Willow. (From a Photograph.)

Insect eggs of many other kinds were found in the food of the chickadees. Many of these it was impossible to recognize, but there was no difficulty in identifying the eggs of the common American Tent Caterpillar,[1] the egg mass of which is illustrated in Fig. 4, and of the Fall Canker Worm,[2] the eggs of which as found upon elm are represented in Fig. 5. There were also present the eggs and egg sacs of many spiders of kinds commonly occurring under loose bark (Fig. 6). While spiders as a class are doubtless beneficial creatures, the destruction of some of them is not in my opinion seriously detrimental to the usefulness of the chickadee.

The larvæ of several different kinds of moths were also found. One of the most abundant species was believed to be the common apple worm, the larva of the codling moth (Fig. 7). It was difficult to be sure of the species, because the heads of the larvæ were nearly always absent, but there is little doubt

[1] *Clisiocampa Americana.*
[2] *Anisopteryx pometaria.*

Digitized by Google

as to its identity. Another larva commonly found was one which winters over on the twigs in a small silken case, as shown in the light spots in Fig. 8. The bark beetles of the family *Scolytidæ*, which are destructive to forests all over our country, were also freely eaten by the chickadees. Some birds which had passed through the pine woods of the College farm were found to have eaten many of these beetles, the precise species being determined by Mr. E. A. Swarz of the United States Department of Agriculture, as *Pityogenes sparsus* Lec. So much of the time of these birds is spent in the woods that it is evident that they are of great benefit in destroying bark-beetles and other pests of forest trees.

FIG. 4. Egg-mass of American Tent Caterpillar. (These eggs are eaten by Chickadees.)

The hairy skins of the fruit of the common wild sumachs were among the most abundant elements of the vegetable food present. The edible portion of these fruits is evidently eaten to a considerable extent throughout the winter.

THE RESULTS IN DETAIL

On the assumption that the scientific details of this study of the chickadee's food will not be of especial interest to the general reader, the following records are printed in smaller type, and may be passed over by any one who cares only for the general results.

But one specimen taken in November (the 12th) was studied. It had been killed after a tour through the tops of the pines in the College woods, and the stomach was chiefly filled with the fragments of small beetles belonging to the family of bark beetles (*Scolytidæ*). These were estimated to form 85 per cent. of the entire contents. There were also five large eggs of an insect which were identified by

Digitized by Google

Dr. L. O. Howard as belonging to some species of the family *Reduviidæ*, making 2 per cent.; three small larvæ, apparently of the order Diptera, 1 per cent.; fragments of sumach berries, 2 per cent., and undetermined material, 10 per cent.

The next specimen was taken December 9th in an apple tree, it having previously been followed through a mixed growth of young pines, maple, willow, and birches. The stomach was nearly full of the eggs of aphides, 429 of these being counted in the mass; they were estimated to form 70 per cent. of the stomach contents. There were also present a small moth, 4 per cent.; a Carabid beetle, 5 per cent.; a snout beetle, 4 per cent.; two insect larvæ, 4 per cent.; an egg of the fall canker worm, 1 per cent.; feathers a trace, and undetermined material, 1 per cent.

FIG. 5. Eggs of Fall Canker Worm on Elm Twig. (Chickadees feed freely on these Eggs.)

The first specimens collected in January were taken on the 19th at 2 p. m., and consisted of four birds which had just passed through a young growth of grey birches, apple and maple trees growing in a neglected pasture. Three of these had eaten largely of vegetable matter which was doubtfully identified as the buds of some small plant; this material constituted 70 per cent. in two of the specimens and 75 per cent. in the third. The first bird had eaten in addition the following: Three insect larvæ, 1 per cent.; about 45 insect eggs, 5 per cent.; undetermined insects, 2 per cent.; small seeds, 6 per cent.; undetermined material, 8 per cent. The second specimen had a somewhat similar record, except that 6 per cent. of aphid eggs had been eaten. The third had eaten a large geometrid larva, forming 5 per cent of the food. The fourth chickadee of this lot had partaken of a somewhat different food from the other three. The principal item in its bill of fare consisted of material which was believed to be the skins of apples hanging from the trees, making 40 per cent. of the total food; plant-lice eggs formed 6 per cent.; eggs of fall canker worm, 4 per cent.; a lepidopterous larva, 10 per cent.; a large bud of a deciduous tree or shrub, 8 per cent.; small buds, 6 per cent.; and material not determined, 26 per cent.

Two chickadees were taken in Durham among some grey birches on the banks of the Oyster River at 10 A. M., February 14th. Both had

Digitized by Google

eaten largely of the small bud-like materials already noted, making 58 per cent. of the food in one and 37 per cent. in the other case. The other food elements of the first were aphid eggs, 24 per cent.; undetermined insects or their allies, 4 per cent., and undetermined material, 14 per cent. The stomach of the second specimen contained very little food, a caterpillar making 33 per cent., undetermined insects 8 per cent., grit 5 per cent., spiders 4 per cent., and undetermined material 13 per cent.

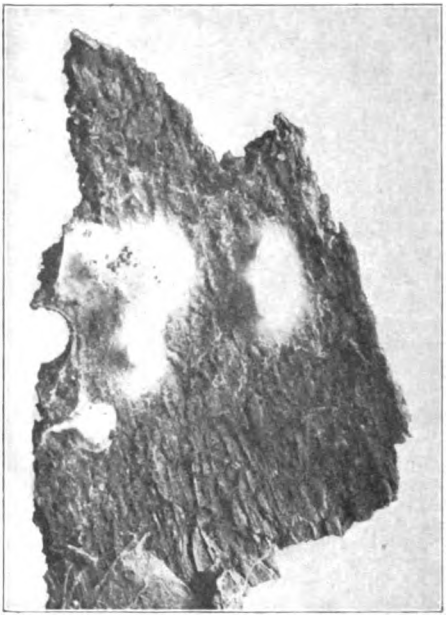


FIG. 6. Egg-sacs of Spiders on loose bark.

Four chickadees taken February 17th while feeding in a mixed growth of birch and pine had eaten chiefly aphid eggs, these constituting 62 per cent. of the entire food of the first specimen, 52 of the second, 46 of the third, and 61 of the fourth. In addition, one bird had eaten the eggs of the common American tent caterpillar to the extent of 16 per cent., and another had eaten a few specimens of a small flea beetle known to science as *Prasocuris varipes*. (Fig. 9.) The other food elements were certain small round bodies of unknown origin, eggs of insects, bud scales, and seeds of birch.

Another chickadee feeding in an apple tree February 17th had eaten 60 per cent. of the skins of sumach berries, 28 per cent. of aphid eggs, 3 per cent. of the eggs of bugs of the family *Reduviidæ*, and 2 per cent. of bud scales, while 7 per cent. was not determined. Still another killed on the same day in a clump of small pine trees had taken aphid eggs 19 per cent., bud scales 49 per cent., feathers 1 per cent., a spider, 2 per cent., and undetermined material 29 per cent.

FIG. 7. The Codling Moth.

Three chickadees were shot in an apple orchard February 19th, at 3:30 p. m. Their food was estimated as follows:

Digitized by Google

No. 1. Eggs of aphids, .05; cocoon and larvæ of codling moth (?), .15; spider eggs and egg sac, .28; undetermined insects, .11; undetermined vegetable matter, .18; undetermined animal matter, .22; grit, .01.

FIG. 8.—Winter cases of a small caterpillar beside apple buds. (They show as light spots.)

No. 2. Five codling moth larvæ (?) .67; cocoon of codling moth (?) .07; eggs of aphids, .12; small beetle *(Hoplocephala bicornis?)* .01; eggs of insect. .01; eggs of spiders, .01; spider, .02; buds, .05; undetermined material, .04; feathers, trace.

No. 3. Eggs of aphids, .52; lepidopterous larvæ, .28; two spiders and web, .10; bud scales, .03; undetermined, .07.

The next specimen was killed at 3 p. m. February 18th while picking at a small twig of a birch tree. It had evidently been eating the eggs of the plant-lice that are so abundant beside the buds of the birch, as 74 per cent. of the food consisted of aphid eggs, of which two sizes were present;—the smaller were probably those of the birch species. In addition there was a caterpillar, making 4 per cent.; small cocoons apparently of hymenopterous insects, 2 per cent.; bud scales, 9 per cent.; undetermined insects, 2 per cent.; and other material, 9 per cent.

Another chickadee taken at the same time in a similar situation contained 52 per cent. of aphid eggs and various other materials.

Two chickadees were taken at 4 p. m. February 26th at Durham Point in a mixed growth of pines and birches. One of these had eaten 454 eggs of aphides, making 44 per cent. of the food, and an equal percentage of material that seemed to be the dried castings from the old nests of tent caterpillars. In addition there were feathers, spiders' eggs, canker worm eggs, and woody matter, each estimated at 1 per cent., as well as 8 per cent. of undetermined material. The other bird contained the following: A good-sized fly, 11 per cent.; nine spiders—one large, one medium, seven small—24 per cent.; two spider egg-sacs, 10 per cent.; canker worm eggs, 2 per cent.; a measuring worm (*Geometridæ*), 22 per cent.; feathers, 1 per cent.; and undetermined material, 30 per cent.

FIG. 9—Flea beetle. magnified (Eaten by chickadee.)

Three chickadees were shot on March 4th at about 11:30 a. m. They belonged to a large flock which had been flying from tree to tree through the woods. The first had eaten 42 per cent. of aphid eggs, 18 per cent. of buds and bud scales. 9 per cent. spider and web, 2 per cent. of beetles, 6 per cent. of sumach fruits, 2 per cent. of oval brown insect eggs, and 21 per cent. was undetermined. The second specimen had eaten a large spider making 37 per cent. of the whole, and some spider's web making 7 per cent. more; leaf-hoppers of the family *Jassidæ*, 4 per cent.; eggs of fall canker worm, 4 per cent.;

Digitized by Google

a moth and pupa, 12 per cent.; the winter cases of a tineid, 3 per cent.; sumach berries 7, and undetermined material, 26 per cent. The third specimen was remarkable for the number of insect eggs which it had eaten. There were 121 good-sized eggs of aphides and 147 small eggs of aphides, the two together making 52 per cent. of the total food; in addition there were 20 reduviid eggs, making 9 per cent.; 15 round black and white eggs with a recticulate surface, 9 per cent.; and 15 oval, pointed, white eggs, making 5 per cent. Spiders and their cases made 6 per cent.; a lepidopterous larva, 3 per cent.; a beetle larva, 4 per cent.; a lepidopterous and hymenopterous cocoon, 1 per cent. each; five small larvæ, probably dipterous, 5 per cent.; bud scales, 1 per cent., and undetermined material, 4 per cent.

FIG. 10.—Nightflying moth (*Scopelosoma*). Eaten by chickadees

The next specimens studied were three birds taken at 1 p. m. March 4th, in small trees in a pasture. They had been feeding leisurely in trees or shrubs of birch, apple, alder, cedar, and barberry. Two of these had eaten many plant-lice eggs, and many other insects, while a third had eaten a variety of insects.

A chickadee taken about 2 p. m. March 4th in a small lot of pine in a pasture contained the following: Pupa of a lepidopterous insect, 11 per cent.; a lepidopterous larva, 16 per cent.; a spider, 10 per cent.; small hymenopterous cocoons, 24 per cent.; bud scales, 6 per cent.; sumach fruits, 8 per cent., and 25 per cent. was undetermined. About an hour later another bird was shot in a growth of hemlocks. "The circumstances," according to Mr. Fiske's notes, "were quite peculiar, the bird having flown to the ground and being in the act of picking at a piece of dead bark which had fallen from a tree. It was killed instantly, and when picked up had scarcely moved, except to open its wings a little. It had been picking at a nest of spiders' eggs, and the bill was still full of eggs, and in almost the precise position which the bird had assumed in the act of eating." The food record of this specimen was not, however, a very full one: In addition to the spider eggs the bird had swallowed there were aphid eggs 1 per cent.; bud scales, 32 per cent.; sumach fruits, 8 per cent., and 45 per cent. could not be determined.

About 4:30 p. m. March 4th, five chickadees were taken in an open pasture in which were many scattered trees. The birds were busily feeding, and had been noticed on apple, barberry, poplar, hemlock, elm, willow, birch, beech, and oak. The food contents are indicated in the following summaries:

No. 1. Pieces of sumach fruit, .46; eggs of aphides, .11; an insect larva, .21; spider's web, .08; eggs of insects, .04; feather, .01; undetermined arthropods, .04; undetermined material, .05.

No. 2. Stomach very full: aphid eggs, .23; spider eggs and egg-sac, .06; leaf-hopper (*Jassidæ*), .03; insect eggs, .05 (1 per cent. of them thought to be those of the forest tent caterpillar *Clisiocampa*

Digitized by Google

disstria); adult flies (Diptera), .06; puparia of flies, .09; lepidopterous pupæ, .05; insects undetermined, .27; seed of Polygonaceæ, .02; bud scales .01; undetermined material, .13.

No. 3. Stomach full. Eggs of aphides, .35; spider eggs and web, .22; larvæ, believed to be those of the codling moth, .12; other lepidopterous larvæ, .06; undetermined insects, .09; insect larvæ, .03; spider, .04; bud scales, .03; undetermined material, .06.

No. 4. Eggs of American tent caterpillar *(Clisiocampa Americana)*, .06; spider, .16; cocoon of spider, .11; aphid eggs, .04; eggs of fall canker worm, .02; beetles, .03; sumach fruits, .44; bud scales, .08; undetermined material, .06.

No. 5. A large noctuid larva, .44; insect eggs (Reduviidæ?), 19; aphid eggs, .06; insect larvæ, .08; sumach fruits, .07; bud scales, .06; undetermined material, .10.

The next specimen was taken March 11 at 10:30 a. m. in a growth of birch. It contained: aphid eggs, .24; geometrid larva, .12; beetles, .09; hymenopterous cocoons, .12; spiders and their web, .09; lichens, .05; bud scales, .11; and undetermined material, .18.

On March 26th a chickadee was shot at 8:30 a. m. It was one of a flock that was apparently emerging for the first time that day from a small grove thickly set with pine trees. There was very little food in the stomach, all of which appeared to be undigested material from the food of the day before. The only recognizable elements were bud scales, spider's silk and pieces of the legs of insects and spiders.

On March 26th, five chickadees were shot in a sugar orchard, and in apple trees near by. One of them had in its bill when killed the abdomen and part of the wings of the moth represented natural size in Fig. 10 and known to entomologists as *Scopelosoma indirecta*.

The food contents of these specimens were as follows:

No. 1.—Moth, .90 (*Scopelosoma*); eggs, probably from the abdomen of moth, .02; aphid eggs, .02; cocoon of spider, .03; undetermined, .03.

No. 2.—Moth, .27; beetles, .12; spiders, .14; small white egg of an insect, .01; small hymenopterous insect, .01; bark, .12; undetermined vegetable tissue, .26; feathers, .01; undetermined material, .06.

No. 3.—Noctuid moth, .61; bug (*Reduviidæ*), .03; spider, .16; web of spider, 04; undetermined arthropods, .12; undetermined vegetable matter, .04.

No. 4.—Three insect larvæ, probably lepidopterous, .28; small beetles, .05; bark-lice (*Coccidæ*), apparently oyster-shell bark-louse (*Mytilaspis pomorum*), .01; aphid eggs, .01; spider, .06; bud scales, .23; bark, .14; undetermined vegetable matter, .22.

No. 5.—Two lepidopterous larvæ, .38; lepidopterous pupa, .32; dipterous larvæ .14; undetermined adult arthropods, .08; lichen, .01; bud scales, .02; undetermined vegetable matter, .03; feather, .02.

The last specimens of the winter were taken by Mr. Dearborn at 11.00 a. m. on March 29th. They were feeding near the ends of high branches of a large chestnut tree at Northfield, Merrimack Co., New Hampshire. Apparently comparatively little food had been taken that morning, the stomach of the first specimen containing 44 per cent. of bud scales, probably largely left over from the day before, and 30 per

Digitized by Google

cent. of undetermined vegetable matter. In addition there were 9 per cent. of aphid eggs, an equal ratio of adult insects, and 8 per cent. of insect larvæ. The second had eaten even less that morning, there being only a few skins of aphid eggs, and the rest of the material consisting of bud scales and undetermined vegetable matter.

TABLE I.—FOOD OF THE CHICKADEE.

Months.	Nov.		Dec.		Jan.		Feb.		March.		Summary.	
No. of specimens each.	1		1		4		15		20			
KINDS OF FOOD.	No. of spec.	Per cent. of whole.	No. of spec.	Per cent. of whole.	No. of spec.	Per cent. of whole.	No. of spec.	Per cent. of whole.	No. of spec.	Per cent. of whole.	No. of spec.	Per cent. of whole.
Arthropoda (undetermined)	....	....	....	....	....	....	1	....	3	.01	4	.005
Insecta "	....	....	....	....	2	.03	5	.02	5	.03	12	.03
Insect eggs "	....	....	....	....	1	....	3	.01	7	.02	11	.015
Insect larvæ "	....	....	1	.04	....	....	....	....	6	.04	7	.02
Coleoptera "	....	....	....	....	....	....	1	.01	7	.04	8	.02
Scolytidæ	1	.85	....	....	....	....	....	....	....	....	1	.02
Carabidæ	....	....	1	.05	1	....	....	....	....	....	2	
Tenebrionidæ	....	....	....	....	....	....	1	....	....	....	1	
Chrysomelidæ	....	....	....	....	....	....	1	....	....	....	1	
Curculionidæ	....	....	1	.04	1	.01	....	....	....	....	2	
Larvæ	....	....	....	....	1	....	1	....	3	.02	5	.02
Lepidoptera (undeterm'd)	....	....	1	.04	1	.01	....	....	4	.10	6	.06
Eggs "	....	....	....	....	1	....	3	.01	1	...	5	
Anisopteryx pometaria	....	....	1	.01	2	.03	2	.01	2	.01	7	.015
Clisiocampa	....	....	....	....	....	....	1	.01	2	.01	3	.01
Larvæ (undetermined)	1	.01	....	....	2	.03	4	.06	8	.06	15	.065
Carpocapsa pomonella?	....	....	....	....	....	....	2	.06	1	.01	3	.025
Pupæ (undetermined)	....	....	....	....	1	....	1	....	6	.02	8	.01
Diptera	....	....	....	....	1	....	1	.01	2	.01	4	.01
Larvæ	....	....	....	....	1	....	....	....	4	.02	5	.01
Puparia	....	....	....	....	....	....	....	....	1	.01	1	.005
Hemiptera (undetermi'd)	....	....	....	....	....	....	....	....	1	....	1	
Jassidæ	....	....	....	....	....	....	....	....	2	.01	2	.005
Coccidæ	....	....	....	....	....	....	....	....	1	....	1	
Eggs (Reduviidæ)	1	.02	....	....	....	....	4	.01	2	.01	7	.01
(Aphididæ)	....	....	1	.70	3	.06	13	.35	14	12	31	.21
Hymenoptera	....	....	....	....	....	....	....	....	1	....	1	
Cocoons	....	....	....	....	1	....	1	....	3	.02	4	.01
Spiders	....	....	....	....	....	....	5	.03	11	.06	16	.04
Eggs	....	....	....	....	....	....	4	.03	4	.03	8	.025
Vegetable matter (undetermined)	....	....	....	....	....	....	1	....	5	.04	6	.02
Bud- and bud scales	....	....	....	....	4	.56	9	.10	15	.10	28	.14
Sumach fruit	1	.02	....	....	....	....	4	.05	7	.07	12	.04
Seeds	....	....	....	....	2	.03	3	.01	1	....	6	.01
Lichens	....	....	....	....	....	....	....	....	2	....	2	
Insect excrement (?)	....	....	....	....	1	.01	5	.09	...	....	6	.03
Spiders' silk	....	....	....	....	....	....	2	.01	9	.02	11	.01
Undetermined	1	.10	1	.11	4	.24	15	.12	20	.10	41	.11
SUMMARY.												
Insecta	....	87	....	88	....	16	....	56	....	58	....	57.5
Arachnida	....	...	....	...	....	....	....	6	....	9	....	.065
Vegetable matter	....	.02	...	...	....	.59	....	.16	....	.21	....	.21
Extraneous "	....	.01	....	.01	....	.09	....	.09	....	.02	....	.04
Undetermined matter	....	.10	....	.11	....	.24	...	.12	....	.10	....	.11

Digitized by Google

ABUNDANCE AND FEEDING HABITS

In order to get some idea of the abundance of chickadees in a region like south-eastern New Hampshire, where a considerable portion of the land is wooded, I requested Mr. Fiske to spend a day in the woods and fields, recording the number of flocks of chickadees seen, the approximate size of each flock, and observing their feeding habits. He has summarized his observations in the following paragraphs:

"In the course of the day, a distance of about seven miles was traversed, without taking into account the many minor deviations in the route; four square miles would seem a reasonable estimate of the area covered. Eleven flocks of chickadees were seen, varying in numbers from four to forty, but averaging about thirteen in each flock. Estimating the amount of territory covered at four square miles, this would place the number of birds for each square mile at thirty-five, which certainly seems a reasonable estimate.

"During the forenoon, the birds were not very busy feeding, and all the flocks encountered were traveling through the woods at a rate somewhat faster than was pleasant to follow on foot, each bird stopping for an instant at any especially tempting tree or dead stub, and then hastening on to join its companions. In the afternoon, especially toward evening, the birds encountered seemed to be attending much more closely to feeding. Instead of traveling across country, the flock would scatter over a section of woodland or pasture, each bird searching closely the crevices in trees, stumps, and fences. A peculiar habit which I had not before noticed is worthy of mention: when one of the chickadees wished to investigate some crevice or bunch of lichen where it could not obtain a foothold, it would hover before it a moment in the air, as a hummingbird hovers before a flower.

"These remarks apply to a day in early March, which, while not sunny, was still fairly warm and quiet. During the darker days of January and February, when the snow lies deep and the wind is often cold and sharp, the daily life of the chickadee is quite different. Several trips into the field for material for study were made in February, and the birds

Digitized by Google

were then confined more closely to the evergreen woods and other situations equally sheltered, seldom venturing out into open pastures and fields. In the College woods, which are largely composed of tall pines, there was almost always a flock to be found by very little searching, flying from tree to tree far up in the tops, and scrutinizing closely each mossy limb, or alighting on the terminal twigs and picking something out of the leaf clusters. They did not confine themselves to the tall growth by any means, but, in a little clump of trees, very similar to that represented in Figure 11, there was a colony to be found at almost any time during the latter half of February."

ENCOURAGING THE PRESENCE OF CHICKADEES

Fortunately, these useful birds are easily induced to remain upon the premises, where their services, in destroying the insect enemies of orchards, vineyards, and other plantations, will abundantly repay the slight trouble necessary to lead them into a condition of semi-domestication. It has been repeatedly observed by bird lovers in many parts of the Northern states that the chickadees are common in city parks, and about premises in which there are evergreens in which they may find shelter during the storms of winter. Numbers of observers have found that by placing bones with a little meat attached to them in a tree, the chickadees and other winter birds are attracted to it, while in one instance the birds became so tame that they would alight on the person who was studying their habits. Mr. Fiske has had abundant opportunity to study this phase of the subject upon his father's farm in Webster, New Hampshire, and furnishes the following summary of his observations:

"Chickadees may readily be taught to come around the house, if fed regularly, and a flock of them thus partially tamed may be the source of much amusement to one having a liking for birds. They are fond of almost any food of an animal nature, especially if it contain more or less fat; they will also eat farinaceous food to a certain extent, being quite partial to bits of brown bread. If supplied with a surplus of food in the shape of small fragments, they will, after eating all that

Digitized by Google

they can, carry away large quantities and tuck it away in crevices in the bark, or at the base of twigs, in some neighboring tree. If the wood-pile is handy, it affords numerous opportunities for this purpose, and is freely used. This habit of stor-

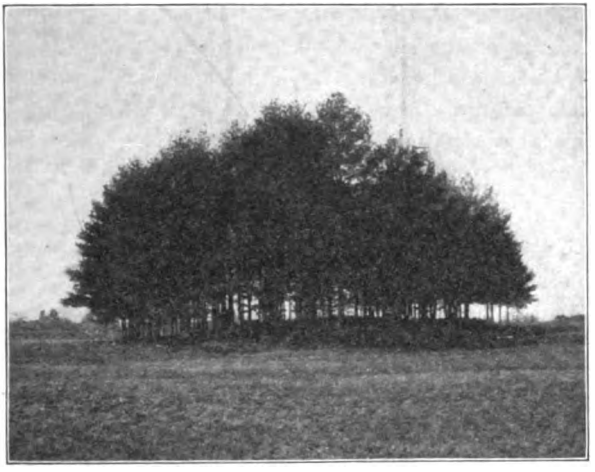


FIG. 11. A Refuge for Birds.

ing food is of great benefit to the blue jays, who, if the food is displayed on a window-shelf, or some similar situation, dare not get it for themselves, but will hang around until it is stored away by the chickadees, when they will steal the morsels from their hiding places."

The protection which a pine grove affords to chickadees and other winter birds is one reason why it is desirable to have such a bit of woodland on or near the farm. It also serves as a shelter to many other birds during the summer season.

A remarkable example of the benefit that may be derived from the presence of a flock of chickadees, has been recorded by Mr. E. H. Forbush, in a bulletin of the Massachusetts State Board of Agriculture. In a certain orchard in Massachusetts, canker-worms had been abundant the previous season, and the moths of the fall canker-worm had deposited great numbers of eggs upon the trees. Pieces of meat, bone, or suet were fastened to the trees early in the winter, to attract the chickadees.

Digitized by Google

The birds came, and remained about the orchard nearly all winter. They were carefully watched, it being found that they were feeding on the eggs of the canker-worm moth. A few birds were killed, to determine the number of eggs eaten. Between 200 and 300 canker-worm eggs were found in the stomach of each of these birds. In the spring, the female moths of the spring canker-worm were also devoured by these birds. The result was that the chickadees, assisted in spring and early summer by various other birds, saved the orchard from any serious injury by the canker-worms.

CONCLUSION

The investigations recorded in this Bulletin, show that the chickadee is one of the best of the farmer's friends, working throughout the winter to subdue the insect enemies of the farm, orchard, and garden. For the efficient service thus rendered the bird asks no pay, although it may be induced to remain more of the time upon the farm premises, if bones or suet are hung in trees where the birds may get it during winter.

Digitized by Google

Sci 1636.35

The Feeding Habits of the Chipping Sparrow

BY CLARENCE M. WEED

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

Bulletin 55 July, 1898

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*

ASSISTANTS

ELWIN H. FORRISTALL, B. S., *Superintendent of Farm.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
ERNEST J. RIGGS, B. S., *Assistant Horticulturist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
CLEMENT S. MORRIS, *Clerk.*

BULLETINS OF 1898.

Bulletin 49—Inspection of Fertilizers. January.
Bulletin 50—Dehorning Cattle. February.
Bulletin 51—Sweet Corn in New Hampshire. March.
Bulletin 52—Growing Muskmelons in the North. April.
Bulletin 53—The Farm Water Supply. May.
Bulletin 54—The Winter Food of the Chickadee. June.
Bulletin 55—Feeding Habits of the Chipping Sparrow. July.

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

An Observation on the Feeding Habits of the Chipping Sparrow

BY CLARENCE M. WEED

IT is now generally acknowledged that birds are of great importance as checks upon insect life. The studies made by several American investigators upon the food of birds have shown beyond all doubt that these feathered allies of the farmer are essential to successful agriculture.

In the investigations yet recorded there have been comparatively few observations of the precise daily feeding habits of birds under natural conditions. This is necessarily so because of the difficulty of making such observations. In this short bulletin I wish to record a series of observations made during one long day in June (the 22d) by my assistant, Mr. W. F. Fiske, and myself upon a family of chipping sparrows (*Spizella socialis*) that had nested in a small juniper near a window from inside of which they could easily be watched. The nest contained three young sparrows, so nearly full grown that they hopped out of the nest the second day after these records were made.

The observations began at 3 : 40 a.m., somewhat before full daylight. The bird was then on the nest and remained there quietly for ten minutes. From this I judged that the daily task had not yet begun, it being too dark before 3 : 40 for even the early worm to be seen. Between 3 : 50 and 3 : 55 the bird left the nest, returning at 3 : 57 with a small object, apparently a piece of earthworm, in its beak. Three hungry looking mouths were widely opened, into one of which the morsel was

Digitized by Google

dropped; then the bird settled down on the nest and remained two minutes, when it left.

Two minutes later both birds returned and fed the young. One picked up excrement from the nest, flew a few feet away, and immediately returned and sat on the nest. At 4:06 the bird on the nest left (at 4:08 the sun rose) and at 4:09 one bird returned and settled on the nest. At 4:13 it got off the nest and caught an insect of some sort on a branch of the little tree in which the nest was placed, the insect being within a foot of where the bird was sitting. This insect was fed to one young bird and the parent bird flew away. The record for the next hour was as follows:

4:16—One bird returned, fed, flew off with excrement.
4:19—One bird returned with food; settled on nest.
4:25—Bird on nest flew away.
4:30—One bird (thought to be the male) lit in a poplar tree near by, flew from branch to branch, then flew into tree in which nest was, fed one young bird with an insect or worm, then flew away.
4:31—The other parent (believed to be the female) returned, fed, and settled on the nest.
4:34—Bird on nest flew off; the other bird came at once, fed, and flew away.
4:35—A parent (believed to be the female) returned, fed, and flew away.
4:38—One old bird (thought to be the female again) returned, fed, and settled on the nest.
4:41—Bird on the nest left.
4:42—A parent (supposed to be the male) returned, fed, and carried away excrement.
4:56—Old bird (supposed to be the male again) returned with food which was given to one of the young, and carried away excrement.
4:58—Old bird (supposed to be the female) returned, fed one of the young, and settled on the nest a minute before flying away.
4:59—The other bird returned, fed one of the young ones, and cleaned the nest.
5:05—Old bird (thought to be the male) returned, fed nestling, and flew away.
5:07—One parent (probably the mother) returned, fed, brooded a moment, then flew away.
5:10—The same bird (apparently) returned, fed, and flew off.
5:12—Again the old bird believed to be the mother, returned, fed, and then settled on the nest.

Digitized by Google

The above record will give a fair idea of the activity of these parents during the day. Between 5 and 6 o'clock food was brought fourteen times; between 6 and 7, seven times; 7 and 8, eleven times; 8 and 9, twelve times; 9 and 10, ten times; 10 and 11, seventeen times; 11 and 12, ten times. The afternoon hours were equally well filled. During the first hour (12 to 1) fifteen visits to the nest were made, while the second hour saw twenty-one visits recorded. Between 2 and 3 the parents came twelve times; between 3 and 4, nine times; between 4 and 5, thirteen times; between 5 and 6, nine times; between 6 and 7, ten times. The day's work closed at 7:50, when it was too dark to see the late worm should he still be wandering about.

THE RECORD IN DETAIL

The detailed record of these observations for the remainder of the day is given below in small type. The essential facts of interest to the general reader are summarized in the paragraphs above and at the end of the bulletin:

5:17—The other parent (supposed to be the male) lit in a tree near by; the female flew off, and the bird in the tree came to the nest, fed one of the young, and flew away.
5:20—The female (?) returned fed, and flew away.
5:26—The male (?) returned, fed, and carried away excrement.
5:32—The female (?) returned, fed, and flew off.
5:34—The female (?) returned, fed, and flew off.
5:36—The male (?) returned, fed, and carried away excrement.
5:44—The female (?) returned, fed, and flew away.
5:51—The male (?) returned, fed, and flew away.
5:51.5—The female (?) returned, fed, and flew away.
5:56—The female (?) returned, fed, and flew away.
6:06—The female (?) returned, fed, and carried away excrement.
6:08—The male (?) returned, fed, and flew away.
6:09—The female (?) returned and flew away without feeding the young.
6:17—The female (?) returned, fed, and flew away.
6:28—One parent returned, fed, and flew away.
6:34—One parent returned with a large, green worm; the nestling to which it was given had considerable difficulty in swallowing it.
6:39—One bird returned with some small insect.
6:44—One parent brought a small, dark-colored larva resembling that of a saw-fly.
(A man working a lawn-mower near the nest was probably the cause of this interval of sixteen minutes.)

Digitized by Google

7:00—Both birds returned at the same time. The object carried by the male was too small to be identified, while the female had a large, green caterpillar, apparently a noctuid larva. This larva was so large that the nestling could not swallow it without assistance from the parent. When the mother came to the nest, the larva was held in the bill transversely. Before it was given to the nestling the larva was turned around so that it ran lengthwise of the bill.

7:14—One parent brought a dark-colored caterpillar and carried away excrement.

7:15—One bird, thought to be the male, has been on a small poplar tree near the nest for the last minute with something in its bill. It has just flown to the tiny cedar shrub near by, then to the tree in which the nest is placed, and back to the poplar at once.

7:17—The bird in the poplar flew to the nest and fed young. The other parent made a flying visit to the poplar and flew away.

7:22—One old bird appeared with a large caterpillar, alighting on the poplar a moment before flying to the nest to give it to a nestling.

7:39—One bird brought a rather large, grey caterpillar and carried away excrement.

7:44—Both birds returned at once, the male with a large larva, apparently a noctuid (the group to which the cutworms belong).

7:52—One parent brought a large, greyish caterpillar.

7:56—One bird, thought to be the male, returned with food and carried away excrement.

7:58—Parent returned with a worm, fed, carried away excrement.

8:05—One parent returned with a small insect, fed, and flew away.

8:09—Parent returned with food, then flew away.

8:12—One parent returned, fed, and flew away.

8:17—One parent returned, fed, and flew away.

8:24—One bird returned to the small poplar tree with a larva, apparently a noctuid, in its mouth. It seemed afraid to go to the nest and remained in the poplar four minutes. Then the other parent returned to the poplar with a worm, looked around a moment, flew to the nest, fed the worm to one of the nestlings, and flew away Meanwhile, the other adult swallowed its worm and flew off without visiting the nest.

8:39—One old bird visited the tree in which the nest was for a moment and then flew away without feeding the young.

8:40—Both parents came at once and fed; one, supposed to be the male, carried away excrement.

8:43—One old bird, apparently the mother, brought a small, dark brown caterpillar, which was fed to a nestling, and carried away excrement.

8:44—One bird (the male[?]) brought small objects, fed, and flew away.

Digitized by Google

8:45—The other bird (the female [?]) brought small objects, fed young, and cleaned the nest.
8:47—One parent (the mother [?]) brought a blackish caterpillar and flew away as soon as it was given to a nestling.
8:58—One parent brought a medium-sized, greenish caterpillar.
9:01—One bird (the male [?]) brought some small insect, fed, and flew away.
9:06—The mother (?) brought a large, green caterpillar.

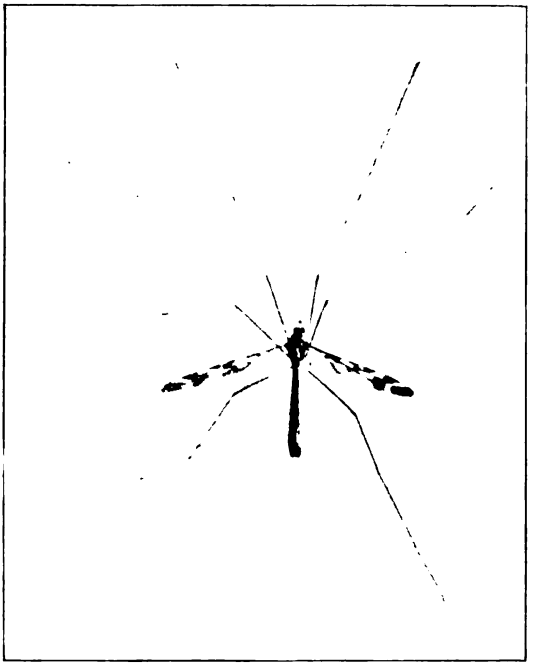


FIG. 1.—A CRANE-FLY (Eaten by Young Chipping Sparrows).

9:07—The male (?) brought some small object.
9:12—The female (?) brought a very large, green caterpillar.
9:13—The male brought some small object.
9:26—One bird brought a large, green caterpillar, large enough to be the larva of *Amphipyra pyramidoides*, and of very much the appearance of that species.
9:38—Both birds returned to the nest at the same time; one had a rather small larva, and the other a large, pale green one. One bird cleaned the nest.
9:39—One bird brought a small, dark caterpillar, and carried away excrement.

Digitized by Google

9:51—One bird brought a large, green caterpillar, coming through the east side of the tree.
10:13—One bird came to north side of tree with very small object; carried away excrement.
10:16—Bird entered tree by north side with small object which was fed to one of the nestlings. The parent remained for some time looking over the young birds.
10:17—Old bird came through east side with what appeared to be a white grub in its mouth; fed to young and flew away.
10:19—Old bird entered by north side with some small object; waited some moments after feeding the nestling, then settled on the nest and warmed the young.
10:24—One of the parents came through the east side of the tree with a large, green worm; one of the nestlings ate it and immediately opened its mouth for more.
10:25—Other parent entered from north side of tree with small object.
10:28—Bird entered from north side again with small, black insect.
10:30—Bird entered from north side with very small object.
10:34—Bird entered from north side with very small object.
10:38—Both birds came at the same time; as usual, the one that entered by the north side brought a small object, and the other a large, parti-colored caterpillar. The second bird carried away excrement.
10:41—Bird entered from north side with a small object.
10:43—Bird entered from north side with a small object.
10:44—Bird came through the east side with a large caterpillar, believed to be the larva of *Amphipyra pyramidoides*.
10:47—Bird came through north side carrying at least two small objects, one of which was given to one nestling and the other to another.
10:54—Bird entered from north side.
10:59—Bird entered from north side.
11:10—Bird entered from north side.
11:14—Bird entered from north side, carrying a larva supposed to be a *Drepanulid*.
11:20—Bird entered from east side with a large caterpillar.
11:23—One bird came from north side with food.
11:24—Bird came from east side with large caterpillar. (It is noticed that the nestling that is fed opens its mouth the widest immediately afterwards.)
11:30—Bird entered from north side with a small object, and carried away excrement.
11:39—Large caterpillar brought through the east side.
11:40—Small object brought through north side.
11:46—Black caterpillar brought through north side.
11:54—Bird entered from east side with brown caterpillar; carried away excrement.
12:01—Bird entered from east side with brown caterpillar.
12:02—Bird returned and fed young.
12:06—Bird returned and fed young.

Digitized by Google

12:10—Bird returned and fed young.
12:18—Bird returned from north side with a green caterpillar, apparently a cabbage worm.
12:24—Bird entered from north side with a good-sized insect.
12:28—Bird entered from north side with a green caterpillar.
12:36—Parent came from east side with a caterpillar.
12:37— Young fed by bird entering north side of tree.
12:38—Young fed by bird entering north side of tree.
12:41—Young fed by bird entering north side of tree.
12:44—Young fed by bird entering north side of tree.
12:48—Bird came through east side of tree with small object.
12:51—Bird came through north side; carried away excrement.
12:56—Bird came through east side with a blackish caterpillar.
1:01—Parent came through north side.
1:05—Both parents returned at once; one came through north side of tree with small object, and the other by east side with a green, downy caterpillar.
1:06—One bird brought a brown caterpillar, entering the tree from the north side.
1:07—Bird brought greenish, black caterpillar through east side of tree.
1:11—Bird entered north side of tree carrying small object.
1:13—Bird entered north side of tree carrying small object.
1:14—Bird entered east side of tree carrying large caterpillar.
1:16—Bird entered north side of tree.
1:24—Bird entered north side.
1:25—Bird entered east side.
1:26—Bird entered north side.
1:27—Bird entered north side.
1:28—Bird entered north side.
1:30—Bird entered north side.
1:36—Bird entered north side; carried away excrement.
1:36.5—Bird entered north side.
1:37—One bird brought a large caterpillar, coming through east side of tree.
1:40—Bird entered north side.
1:51—Bird entered east side.
1:56—Bird entered east side.
2:07—Bird entered east side; carried away excrement.
2:18—Bird entered east side.
2:28—One parent brought a very large caterpillar, coming in at the east side of tree.
2:29—Bird entered north side of tree with small objects, which were fed to two nestlings.
2:33—Bird entered by north side.
2:39—Both parents came at once, each bringing a good-sized caterpillar.
2:41—One bird came through north side with a small caterpillar.
2:45—Bird came through north side.
2:54—Bird came through east side.

Digitized by Google

2:58—One parent brought a large crane-fly (Fig. 1), entering the tree on the east side, and carried away excrement.
2:59—Bird fed nestlings, coming from the north side.
3:11—Bird fed nestlings, coming from the north side.
3:15—Bird fed nestlings, coming from the north side.
3:18—Bird fed nestlings, coming from the north side; carried away excrement.
3:26—Both birds came at once, having been searching the lawn near by for a few minutes preceding.
3:28—One bird came to nest, entering north side.
3:29—Bird brought small object through east side.
3:33—Bird came with food from north side.
3:42—Bird came with food from north side.
4:01—Bird came with food from east side.
4:05—Bird came with a caterpillar from north side.
4:09—Bird came with food from north side.
4:13—Bird came with food from east side.
4:16—Bird brought food, entering at east side.
4:24—Bird brought food, entering at north side.
4:38—An exceptionally large caterpillar brought through east side.
4:43—Bird brought food, entering at north side.
4:45—Bird brought food, entering at north side; carried away excrement.
4:45.5—A large caterpillar was brought in at east side; excrement removed.
4:46—Bird brought food, entering at east side.
4:52—Bird brought food, entering at north side.
4:56—Bird brought a caterpillar, entering at north side. Settled on nest to remain four minutes.
5:23—Both birds came at once, one carrying a small object, and the other a caterpillar.
5:25—Bird brought food, entering at north side; carried away excrement.
5:33—Bird brought food, entering at east side; carried away excrement.
5:39—Bird brought food, entering at north side.
5:42—Bird brought food, entering at east side.
5:45—Bird brought food, entering at north side; fed two nestlings.
5:50—Bird brought food, entering at north side.
5:59—Bird brought food, entering at north side; carried away excrement.
6:01—A caterpillar brought in north side; excrement carried away.
6:06—A black insect, apparently a cricket, brought in north side.
6:15—Small objects brought in at north side.
6:17—Small objects brought in at north side.
6:25—A caterpillar brought; excrement carried away.
6:33—Caterpillar brought through east side.
6:34—Food brought through north side.
6:38—Caterpillar brought; excrement carried away.
6:45—Food brought in at north side; excrement carried away.

Digitized by Google

6:57—Food brought in at north side; excrement carried away.
7:10—Food brought in at north side.
7:16—Food brought in at north side. The sky is clouded, and the atmosphere is now becoming dark.
7:27—Both parents returned; one came through east side, and the other through the north side. One had a large caterpillar, and the other apparently also had one. Both fed and flew away at once.
7:36—One bird came in at north side; fed and flew away at once.
7:49—Now quite dark. One bird flew in, probably the female, got on the nest a moment and then got off and wandered round the tree a minute. Then at 7:50 it settled down on the nest. The young birds poked their heads up for two or three minutes, but the old bird remained quiet, and the young soon withdrew their heads. This was the end of the day's work for the busy parents.

The reason that the side of the tree through which the birds entered was recorded was that it was believed that one of the parents always came through the north side, and the other the east side. But the difference in the sexes is so slight that it was impracticable to be certain of the facts of the case.

SUMMARY AND CONCLUSION

During this busy day the parent birds had made almost two hundred visits to the nest, bringing food nearly every time, though some of the trips seemed to be made to furnish grit for the grinding of the food. There was no long interval when they were not at work, the longest period between visits having been twenty-seven minutes. Soft-bodied caterpillars were the most abundant elements of the food, but crickets and crane-flies (Fig. 1) were also seen, and doubtless a great variety of insects was taken. The precise determination of the most of the food brought was, of course, impossible, the observations having been undertaken especially to learn the regularity of the feeding habits of the adult birds. That they were busy from daylight to dark with no long intermission at any time is shown by the record, and the observation is submitted as a contribution to our knowledge of a subject in which much guessing has been done on account of the lack of definite information.

The chipping sparrow is one of the most abundant and familiar of our birds. It seeks its nesting site in the vicinity of

Digitized by Google

houses, and spends most of its time searching for insects in grass lands, or cultivated fields and gardens. In New England two broods are usually reared each season. That the young keep the parents busy catching insects and related creatures for their food is shown by the record on the preceding pages. The bird certainly deserves all the protection and encouragement that can be given it.

Digitized by Google

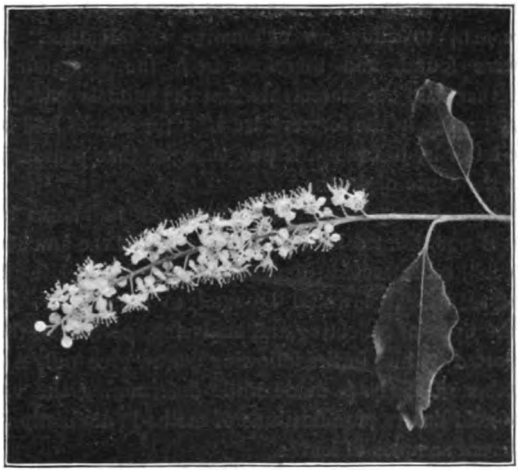
Sci 1636.35

Bulletin 56 **August 1898**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

Poisonous Properties of Wild Cherry Leaves



Flowers of Wild Black Cherry.

BY FRED W. MORSE AND CHARLES D. HOWARD

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

INTRODUCTION

BY FRED W. MORSE

In 1894 and again in 1897 there were received at the Experiment Station, portions of the stomachs of cattle that were supposed to have died of poison in some form. As is apt to be the fact, too small quantities were sent to allow an exhaustive examination. No metallic poisons were found, and therefore from the symptoms preceding death, together with the statements that the animals had had access to wild cherry leaves, in the former case after the shrubs had been mowed and in the latter by browsing, it was thought that prussic acid in the leaves was the cause of death.

Since the different species of wild cherry are numerous beside walls and roads, it was deemed advisable to determine the amount of prussic acid that could be extracted from the leaves and calculate the probable quantity of them, which would be fatal to cows. Mr. Howard was assigned the work of collecting and analyzing specimens, the results of which, reported by him in the following pages, give only a partial idea of the number of analyses made while determining the variations in quantity of acid due to modifications of method (distillation) and those due to different samples of leaves.

Digitized by Google

PRUSSIC ACID IN WILD CHERRY LEAVES

BY CHARLES D. HOWARD

In order to obtain some definite knowledge—of which hitherto, so far as we can ascertain, there seems to have been none—of the amount of poisonous principle yielded by the different species of cherry leaves, and the conditions, if any, favoring such yield, a somewhat detailed investigation has been made, the work of which extended over portions of the past two summers, including July and the first part of August of each year.

There are five members of the cherry family which occur wild in New Hampshire. To name them as nearly as possible in the order of frequency of occurrence, they are: The Wild Black Cherry (*Prunus serotina*), the Choke Cherry (*Prunus Virginiana*), the Wild Red Cherry (*Prunus Pennsylvanica*), the Wild Yellow or "Horse" Plum (*Prunus Americana*), and the Dwarf Cherry (*Prunus pumila*).

The first two species are of quite common occurrence in all parts of the state; the wild red cherry is very common in the mountainous sections, less so in the southern portion of the state; the wild plum is of rarer occurrence, while the dwarf cherry, according to Hitchcock,* has been found only in the town of Campton.

The leaves of the last named species were not examined, though there would seem to be every reason for considering them dangerous. Investigation showed the leaves of the wild plum, as well as those of the cultivated plum, to be harmless. This is not to be wondered at, as while both species belong to the same general family, they are of a different type from the true cherry.

The least poisonous of the three principal species is the wild

*Geology of New Hampshire.

Digitized by Google

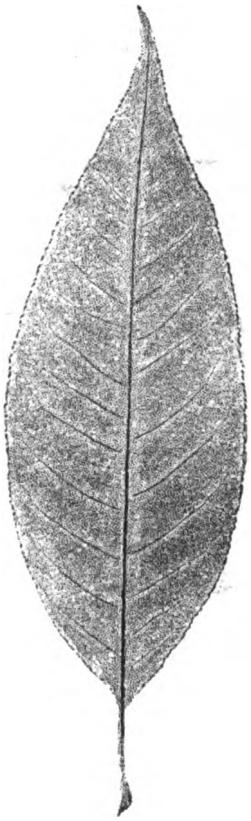


FIG. 1.—Leaf of Wild Red Cherry. Full size.

red cherry, "pigeon cherry," known botanically as *Prunus Pennsylvanica*. This is a shrub, often growing to a small tree, to be recognized by its light, reddish brown bark and waxy, glossy leaves, which are green on both sides, oblong lanceolate in shape, possessing an irregular and sharply serrate edge, the teeth of which are very small and short. (Fig. 1.)

The second species, *Prunus Virginiana*, commonly known as the choke cherry, is more common than the preceding and its leaves are more poisonous. Like the next species, it is to be found as a constituent of the average roadside thicket throughout New England. It is described by Gray as follows:

"Tall shrub, or small tree, greyish bark, oval-oblong or obovate and abruptly pointed thin leaves, very sharply serrate with slender projecting teeth (Fig. 2.); flowers in shorter and closer racemes (than *P. serotina*) in spring; the fruit ripe in summer, red turning dark crimson, astringent, but eatable when fully ripe."

It is a noteworthy fact, serviceable as a means of identification, that this variety is usually more or less affected by black knot, which is never to be found upon the two other species.

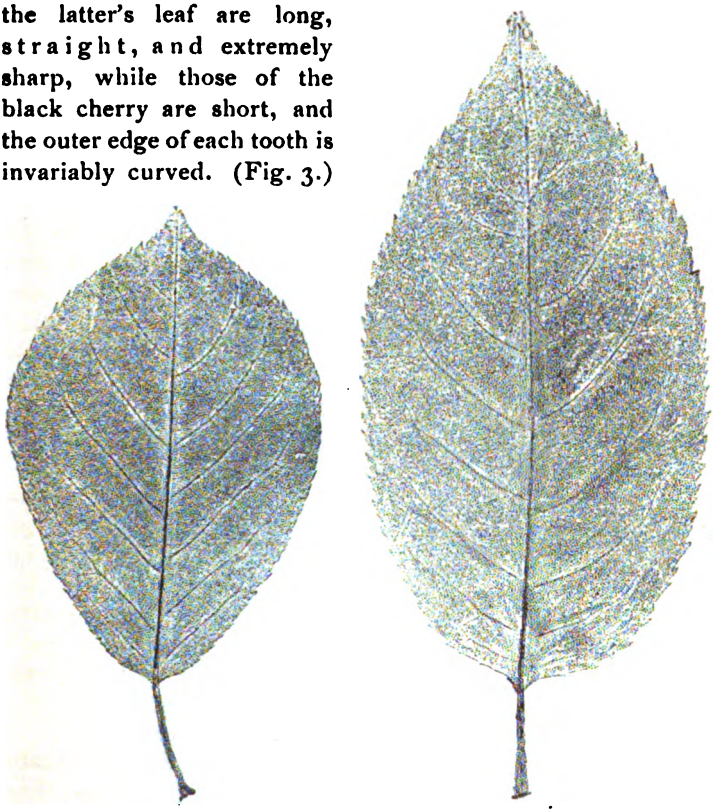
By far the most dangerous variety occurring in New England is the wild black cherry, *Prunus serotina*, thus described by Gray:

"Tree or shrub, westward becoming a good sized forest tree, with bitter aromatic bark, close-grained reddish wood, valued by the cabinet maker; oblong or lance-oblong leaves, thickish or firm texture, usually taper pointed, serrate, with incurved short callous teeth; flowers in

Digitized by Google

long racemes, considerably later than *Prunus Virginiana;* purplish black, bitterish, vinous fruit ripening in autumn."

The edge of the leaf, especially, is very characteristic, and serves to distinguish it from the choke species. The teeth of the latter's leaf are long, straight, and extremely sharp, while those of the black cherry are short, and the outer edge of each tooth is invariably curved. (Fig. 3.)



a. From full grown shrub. *b.* Common type from young shoots.

FIG. 2.—Leaves of Choke Cherry. Full size.

In this section of the state it is probably the most common of the three species, and when not kept down, is to be found growing beside every wall, where it serves as a favorite base of operations for the tent caterpillar.

The poisonous property of all species of cherry leaves is due to hydrocyanic acid, popularly known as prussic acid. This

Digitized by Google

compound does not exist as such in the growing leaf, but is derived from a class of substances called glucosides, of which amygdalin is the type peculiar to the cherry. This, or a

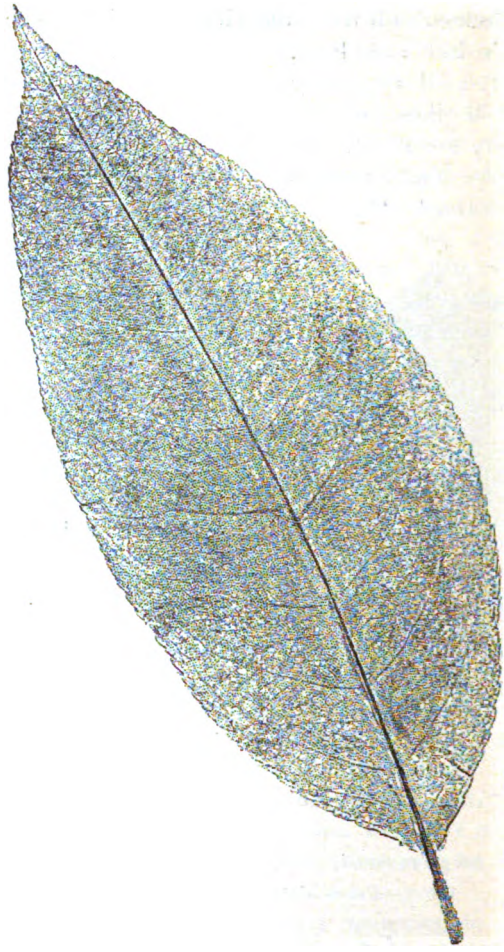


FIG. 3.—Leaf of Wild Black Cherry. Full size.

closely allied body, is to be found not only in the leaves and bark, but especially in the stones of cherries, peaches, and plums, and the seeds of the apple. By the action of moisture and a vegetable ferment called *emulsin*, which exists in the

Digitized by Google

plant, a complex chemical reaction takes place, that begins in the leaf the moment connection with the circulatory system is cut off. The three products of this reaction are hydrocyanic acid, grape sugar, and benzaldehyde, or bitter almond oil.

There is a popular opinion that the leaves of the cherry are poisonous only when cut and in the wilted condition; that cattle may safely nibble them from the growing shrub without danger of injury; and that they are quite harmless when dried. Our observations, however, prove these views to be but partially correct. As a matter of fact, distillations of samples, made within twenty minutes of cutting, show that the freshly cut leaves yield nearly as much acid as the wilted ones do when calculated on the weight of fresh material taken, and when eaten fresh, the character of the juices within the animal stomach is such as to render that organ a most favorable place for the conduct of the reaction in which prussic acid is liberated.

On the other hand, while it is true that the thoroughly dried leaves yield a comparatively small amount of acid, still they may always produce some, and as ordinarily dried in the hayfield, they may be capable of generating a considerable quantity of the poison. The desirability of carefully excluding them from all hay is therefore apparent.

The truth of the preceding statements may perhaps be better comprehended by a study of Table I.

Digitized by Google

TABLE I.

PRUSSIC ACID FROM ONE HUNDRED GRAMS* FRESH, WILTED, AND DRIED LEAVES.

Wild Red Cherry.			Choke Cherry.			Wild Black Cherry.		
Condition.	Milligrams acid.		Condition.	Milligrams acid.		Condition.	Milligrams acid.	
	Calc. on wt. fresh sub.	Calc. on wt. after drying.		Calc. on wt. fresh sub.	Calc. on wt. after drying.		Calc. on wt. fresh sub.	Calc. on wt. after drying.
Fresh :			Fresh :			Fresh :		
Average of six analyses	91.		Two analyses.....	139		Average eleven analy's	212	
Extremes.....	81-100			147		Extremes.....	193-228	
Wilted :			Wilted :			Wilted :		
To 72 per ct. orig. weig't	103	143	To 75 per ct. orig. weight	176	235	To 83.5 per ct. orig. wt..	205	244
To 66.6 per ct. orig. wt..	91	138	To 65 per ct. orig. weight	159	243	To 78.5 per ct. orig. wt..	232	294
Amount wilted not det..	104					To 78.5 per ct. orig. wt.†	213	271
Amount wilted not det..	94					To 66 per ct. orig. wt....	186	282
Amount wilted not det..	105							
Dried :						Dried :		
To 44 per ct. orig. weig't	37	84				To 42 per ct. orig. wt....	30	71
To 45 per ct. orig. weig't	43	95				To 38.5 per ct. orig. wt..	25	65
Amount dried undet....	24							
Amount dried undet....	25							

* 1 gram = 1000 milligrams. 1 gram = 1 grain + 10.4 grains. † See Table II.

Digitized by Google

A marked difference was found between the quantity of acid obtained from leaves wilted in bright sunlight, and the yield from leaves wilted in darkness, the former condition producing the larger amount.

TABLE II.

COMPARISON OF RESULTS FROM WILTING IN SUNLIGHT AND IN DARKNESS.

Choke Cherry Leaves. 100 grams.	Milligrams acid.		Black Cherry Leaves. 100 grams.	Milligrams acid.	
	Calc. in fresh material.	Calc. on wt. after wilting.		Calc. in fresh material.	Calc. on wt. after wilting.
After wilting to :			After wilting to :		
75 per ct. orig. wt.; sunlight.....	176.	235.	78.5 per ct. orig. wt.; sunlight.....	232.	294.
65 per ct. orig. wt.; sunlight.....	159.	243.	78.5 per ct. orig. wt.; mod. light..	213.	271.
78.5 per ct. orig. wt.; darkness....	120.	163.	75 per ct. orig. wt.; darkness.....	187.	250.
70 per ct. orig. wt.; darkness.....	128.	183.	66 per ct. orig. wt.; sunlight	186.	282.
			62 per ct. orig. wt.; darkness.....	118.	190.

One of the most important points to be noted in connection with this subject is the influence that the condition and stage of growth have upon the amounts of hydrocyanic acid occurring in the leaf.

The larger, tenderer, and more succulent the leaf, the greater the amount of acid that can be developed from it. To such an extent is this true, that when we come to consider the dry, woody leaves from full-grown shrubs or trees, we find the quantity of acid they yield to be so little as to render them nearly harmless. The young shoots which come up along the walls, where the custom prevails of mowing the brush every two or three years, are much the richest in the poison-yielding substance.

In the case of the black cherry, analyses were made from four different kinds of growth: (a) large, juicy leaves from suckers; (b) large, vigorous leaves from a young tree ten feet

Digitized by Google

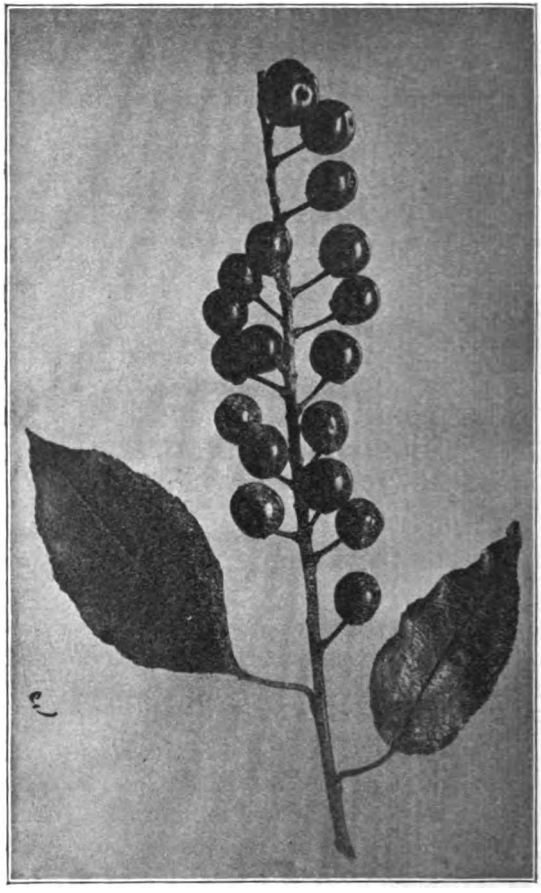


FIG. 5.—Fruit of Wild Black Cherry.

Digitized by Google

in height, growing upon a lawn (c); smaller leaves from a full-grown tree by the roadside; (d) small, dry, woody leaves from stunted shrubs growing in the shade.

TABLE III.

SHOWING INFLUENCE OF CONDITION OF GROWTH.

(Results from 100 grams freshly cut leaves.)

Black Cherry.	Milligrams acid.	Choke Cherry.	Milligrams acid.
(*a*) Leaves from isolated young shoots; large and succulent.		(*e*) Similar to (*a*).	
		Two analyses.....	142
Average of ten analyses..	212		
(*b*) Leaves large, from vigorous young tree grown for ornament.		(*f*) Same as (*e*), but more or less "bored" by insects.	
Two analyses.....	168	One analysis.....	125
(*c*) Leaves smaller, from full-grown tree by roadside.		(*g*) Similar to (*d*) growing in shade, berries nearly ripe.	
One analysis.....	106	Four analyses.....	88
(*d*) Leaves small, dry, and woody.			
Two analyses.....	42		

The average of ten analyses shows that 100 grms (about ¼ lb.) of leaves (a) yield 212 milligrams, or about 3.2 grains, acid, while the same quantity of fresh leaves (d) yields 42 milligrams acid. The same is noticeable of the chokecherry. It has been observed that the most harmful growth in the latter is that in which the large leaves are of the oval-oblong shape (Fig. 2, b). This shape seems to be a peculiarity of the young growths of this species. On the other hand, leaves from mature shrubs seem usually to possess the obovate or inverted egg form (Fig. 2, a).

The symptoms of cherry poisoning in cattle as stated by Dr. Chestnut, in his bulletin, "Principal Poisonous Plants of the U. S.," include, "labored respiration, diminished pulse, numbness, fright, protruding eyeballs, convulsions, and death

Digitized by Google

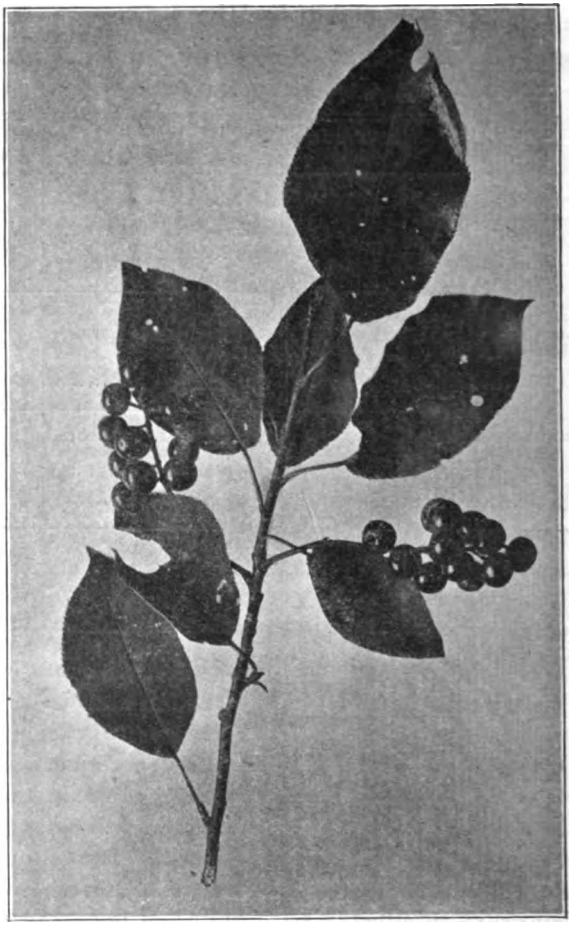


FIG. 6.—Fruit of Choke Cherry.

Digitized by Google

from paralysis of the lungs. In some cases there is considerable frothing at the mouth; in all there is a very perceptible odor of prussic acid in the breath."

According to Blythe, the fatal dose of the anhydrous acid, for an adult person, is about one grain, or 65 milligrams. At this rate, about one half pound of the black cherry leaves may be considered as a fatal quantity for a cow to eat.

During the work this summer several samples each of cultivated plum (*Prunus domesticana*), peach (*Prunus persica*), apple (*Pyrus malus*), and cultivated cherry leaves (*Prunus cerasus*) were analyzed. Those of the plum, apple, and, rather singularly, cultivated cherry yielded no acid whatever. Peach leaves showed from 77 to 100 milligrams per 100 grms. leaves; so that, in this connection, they might be classed with the leaves of the wild red cherry.

To these data may be added a few figures recorded by Blythe in his work upon poisons: One hundred grams of bitter almonds (*Amygdalus communis*), in the form of pulp, yield 250 milligrams prussic acid; the same amount of kernels from cherry stones yields 170 mgs.; leaves of the cherry laurel (*Prunus lauro cerasus*), occurring in Europe and in Mexico, 39 mgs.; kernels of peach, 164 mgs.; plum, 56 mgs.; apple seeds, 35 mgs. The stones of all these species must therefore be regarded as dangerous; the fruit, in every case, so far as can be ascertained, is harmless.

CONCLUSIONS

The leaves of the wild black cherry are the most poisonous of the three species investigated, though all are dangerous.

Both the wilted and fresh leaves are poisonous, while the dried are to be regarded with suspicion.

Vigorous, succulent leaves from young shoots, which are the ones most liable to be eaten by cattle, are far more poisonous than the leaves from a mature tree or stunted shrub.

Leaves wilted in bright sunlight to about 75 per cent. original weight, or until they begin to appear slightly limp and to lose their gloss, yield the maximum amount of prussic acid.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 57 September, 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

Experiments with Roots and Forage Crops

Ensilage Corn

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

CONTENTS

	PAGE
Forage Crops	127
Gramineous	128
Leguminous	135
Miscellaneous	145
Ensilage Corn (illustrated)	128
Japanese Millet	130
Panicum Crus-Galli (illustrated)	131
Italicum "	131
Milleacum "	131
Brazilian Flour Corn	133
Teosinte	134
Kaffir Corn (illustrated)	134
Milo Maize or Dhoura (illustrated)	135
Jerusalem Corn "	135
Soy Bean "	135
Cow Pea	139
Vetch, Russian or Hairy	141
Oats and Canada Peas (illustrated)	141
Crimson Clover	143
Lupine	143
Seradella	144
Sainfoin	144
Rape	145
Kale	145
Spurry	146
Sunflower, Russian	146
Idaho Field or Coffee Pea	147
Sacaline (illustrated)	147
Giant Beggar Weed	148
Root Crops	149
Sugar Beet	149
Wohauka, No. 1 and 2 (illustrated)	149
Lane's Improved "	151
Mangel-Wurzel, Mam. Long Red "	149
Carrot, Long Orange Improved "	151
" " White Belgian "	151
Turnip, Purple Top White Globe "	151
Rutabaga	151
White French (illustrated)	151
Shrivings Purple Top	151
Jerusalem Artichoke (illustrated)	152
Remark	153

Digitized by Google

Experiments with Roots and Forage Crops

BY FRANK WM. RANE

In winter cattle feeding, for the production of milk, many of our leading dairymen seem to regard, among others, a daily ration of green or succulent food as necessary. The source of this food at present in this state is usually the silo or some root crop, mainly the former, although some continue to grow roots.

During the past three years, various forage plants and root crops have been grown at the Station, and will be treated under these general headings.

I.—FORAGE CROPS

The changed conditions brought about through the use of the silo, together with an increasing use of soiling crops, have developed an interest in knowing the relative value of crops used for these purposes. Not only are some of these crops valuable for forage, but, as in the case of most of the legumes, they are likewise valuable for green manuring. Their real value must be solved by the individual. Conditions and kinds of soils, the domestic animals kept, together with conveniences and facilities for handling the crop, go a good way toward solving the problem. The crops considered under this head are classified under the following divisions:

A.—Gramineous forage plants.
B.—Leguminous forage plants.
C.—Miscellaneous forage plants.

Digitized by Google

A.—*Gramineous Forage Crops*

ENSILAGE CORN

Many varieties of ensilage corn have been grown at the Station for the past few years, but the question resolves itself down to two varieties, which, we believe, are the ones best adapted to our conditions, namely, the Leaming and the Sanford. The former is preferable, we believe, for the southern part of the state, and the latter, perhaps, for the northern. Both mature sufficiently for ensilage here at the Station.

The Sanford is too well known to farmers generally to need any recommendation. The first bulletin of the New Hampshire Station in 1888 points out its value for ensilage. Ever since this date, this variety has been the main crop here until three years ago. Last year we planted about half the crop to each. The present season fully three-fourths of the ensilage crop was of the Leaming.

Unlike the Sanford, which is a white flint, the Leaming is a yellow dent corn, and is one of the earliest grown. The ears are large and handsome, with deep grain and a small cob. The stalks grow to a medium size, from one to two feet taller than the Sanford; is very leafy, and usually produces two good ears to the stalk. It adapts itself to various kinds of soils equally as well as the Sanford. The comparative yields of the two varieties during the past seasons have been from two to four tons per acre in favor of the Leaming. Not only has the yield been better, but Professor Morse, who has had charge of the feeding experiments, tells me that the ensilage is equally as good as that of the Sanford, and changing from the one to the other makes no perceptible difference in the milk flow or its composition.

It is hoped that all who are interested in ensilage will give the Leaming corn a small trial at least. Fig. 1, on the cover of the Bulletin, is a photograph of four varieties; beginning at the left hand side, they are, Mosby's Prolific, Leaming, Pisers, and Sanford. Fig. 2 is a photograph of the Sanford as it stood in the field, while Fig. 3 represents the Leaming, taken

Digitized by Google

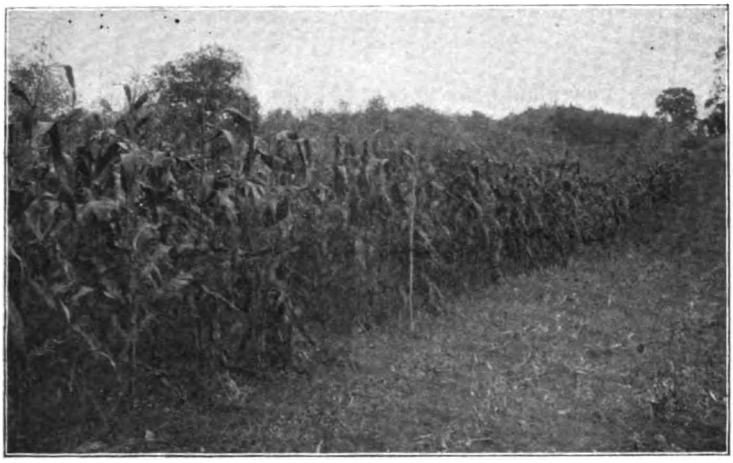


FIG. 2.—Field of Sanford Corn. Average height, 8 feet.

FIG. 3.—Field of Leaming Corn. Average height, 10 feet. Cutting with corn harvester.

Digitized by Google

at the same time. The pole used as a measure stands six feet high in both cases.

JAPANESE MILLETS

These new plants are much like the Hungarian in general appearance, except that they are much larger and coarser. The seed heads are likewise larger, contain proportionately larger seed, are more branched, and produce a heavier yield. Like the Hungarian, they are greedy feeders, and for best results demand a quick and available fertilizer. The seed should not be sown before June nor later than the middle of July, the quantity being at the rate of from two to three pecks per acre. The millets, when used for hay, should be cut soon after the heads are formed and before the seed has set; otherwise the stem becomes fibrous or woody.

In June of 1897, the three varieties of Japanese millets (Panicum miliaceum, P. Italicum, and P. crus-galli), together with two other samples of Japanese millet, each from reliable seedsmen, and a plot each of Golden Wonder and the New Siberian millet, were planted. All of the varieties were under similar conditions; the soil was a clay loam and fairly fertile. On September 3d, all were measured, harvested, weighed, and photographed. The accompanying table will show the comparative yield and measurements, and in Fig. 4 a single specimen of each of the first five varieties is represented by its respective number.

No.	Variety (Millet).	Measurement.	Average weight per acre.
1	Panicum Milleacum	4½ to 5 ft.	10 tons, 1,054 lbs.
2	Panicum Italicum	5 ft.	7 tons, 530 lbs.
3	Panicum crus-galli	5 to 6 ft.	16 tons, 912 lbs.
4	Golden Wonder	4 to 4½ ft.	8 tons, 1,906 lbs.
5	New Siberian	4 ft.	5 tons, 466 lbs.
6	Japanese (Breck)	4 to 4½ ft.	10 tons, 1,296 lbs.
7	Japanese (Henderson)	4½ to 5 ft.	13 tons, 1,104 lbs.

Digitized by Google

FIG. 4.—MILLETS.

1. Panicum Miliaceum.
2. Panicum Italicum.
3. Panicum crus-galli.
4. Golden Wonder.
5. New Siberian.

Digitized by Google

The *Golden Wonder Millet* has been grown very commonly here at the Station, and besides being cured for hay, it is used as a soiling crop.

The *New Siberian* is an exceptionally early variety. It doubtless would have weighed more earlier, as some of its seed was already shelled and the stalk dry. This variety could be planted much later than the others.

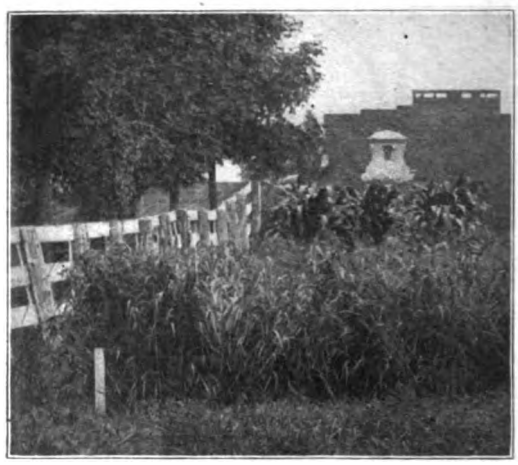


FIG. 5.—Plot of Panicum Miliaceum. (Plot stake 2 feet high.)

No. 6, Japanese Millet (Breck) proved to be a mixture of Golden Wonder and Panicum Miliaceum.

No. 7, Japanese Millet (Henderson) proved to be Panicum Miliaceum alone. From these last two samples, one would conclude that an order for Japanese millet would probably be filled with Panicum miliaceum.

Panicum miliaceum, as shown at No. 1, Fig. 4, and also in the plot, Fig. 5, has a drooping head which is much divided, and when ripe has a tendency to lodge.

Panicum Italicum, as shown at No. 2, Fig. 4, and also in the plot, Fig. 6, much resembles the Golden millet. The head is not so hairy, and the plant stands more erect.

Panicum crus-galli, as shown at No. 3, Fig. 4, and also in

Digitized by Google

FIG. 6.—Plot of Panicum Italicum. (Plot stake 2 feet high.)

the plot, Fig. 7, grows more stalwart and erect, as well as taller than the others. The seed head has many divisions, but they stand very erect. This variety has been the heaviest yielder each year. The present season, about one acre was grown, which has been saved for seed.

These new Japanese millets are, we believe, a valuable acquisition to our forage crops, on account of the brief period necessary for their growth and the fact that they can, to some extent, take the place of either hay or corn in seasons when the latter are failures.

BRAZILIAN OR STOOLING FLOUR CORN

This corn was grown in a test plot in 1897, and grew to a height of ten feet. It was just in blossom when cut in September, making it too late for this climate. The plot looks like, and is similar to, those varieties of corn that are very prolific in suckers. Where it matures, it is said to produce a white grain, suitable for domestic uses when ground. Its yield of fodder was at the rate of 20 tons per acre.

FIG. 7.—Plot of Panicum crus-galli. (Plot stake 2 feet high.)

Digitized by Google

TEOSINTE (*Reana luxurians*)

This is another of the corn type of plants. It is noted for its stooling or suckering habits. Doubtless there is no forage plant that equals it in this respect. Its origin is South America. It was grown at the Station in 1896, and did fairly well, but not in comparison with ordinary corn. Under favorable conditions, it is said to produce as high as four cuttings in a season. Its height varies from 3 to 7 feet.

FIG. 8.—Non-saccharine sorghums. (Tallest 9 feet.) Jerusalem corn. Kaffir corn. Milo maize.

KAFFIR CORN

Three varieties,—white, red, and black chaff—have been grown at the Station. They are non-saccharine sorghum, and all closely resemble one another. The white averaged from 4 to 5 feet in height, the red 4 feet, and the black chaff 5 to 6 feet. None of the varieties mature ordinarily in this climate. In 1897 about one-sixth of the white-headed came out, and none of the red or black chaff. The comparative weights of fodder per 30 foot row was, for the white, 69½ pounds; red, 59 pounds; black chaff, 103 pounds.

The seed of these plants, like that of the sorghums, is borne in the heads of the plants. The name distinguishing each is

Digitized by Google

typical of the color or characteristics of the seed; the white having white seed, etc. They are highly valued in some sections of the South-west, where they are grown, not only for the fodder, giving a number of cuttings each season, but also for the grain, which yields from 25 to 50 bushels per acre. The grain, when ground, compares favorably with corn meal as a feed.

MILO MAIZE OR DHOURA

This plant belongs to the same general family as the Kaffir corn, which it resembles. It reached a height with us of 6 feet, but the heads did not have time to fully open. On a 30 foot row it gave a yield of 73½ pounds, the stalks standing about 3 inches apart in the row. There are many other varieties of the Milo maize. We have grown the white, also the brown Dhoura.

JERUSALEM CORN

This is similar to the two preceding plants, only not quite as tall, nor as heavy a yielder. From a 30 foot row, the yield was 54 pounds. The plant does not mature in this climate.

B.—*Leguminous Forage Crops*

THE SOY BEAN (*Glycine hispida*)

This plant has been under cultivation at the Station for the past four seasons; it is an introduction from Japan, where it has been cultivated from a very early time. The Soy bean has been known in this country for some time, but it is only within recent years that its value has been demonstrated. Its main value, and that for which we have been growing it, is as a forage crop. The composition of the plant shows a high percentage of food ingredients, and, as it is one of the leguminous plants, it doubtless derives much of its nitrogen from the air.

There are many varieties, which at present are classified by a few seedsmen into early, medium, and late; others offer simply Soy or "Soja" beans, which we find are usually the late variety. In 1895, about three-fourths of an acre was grown, but due to an early frost was not harvested in the best condition. This

Digitized by Google

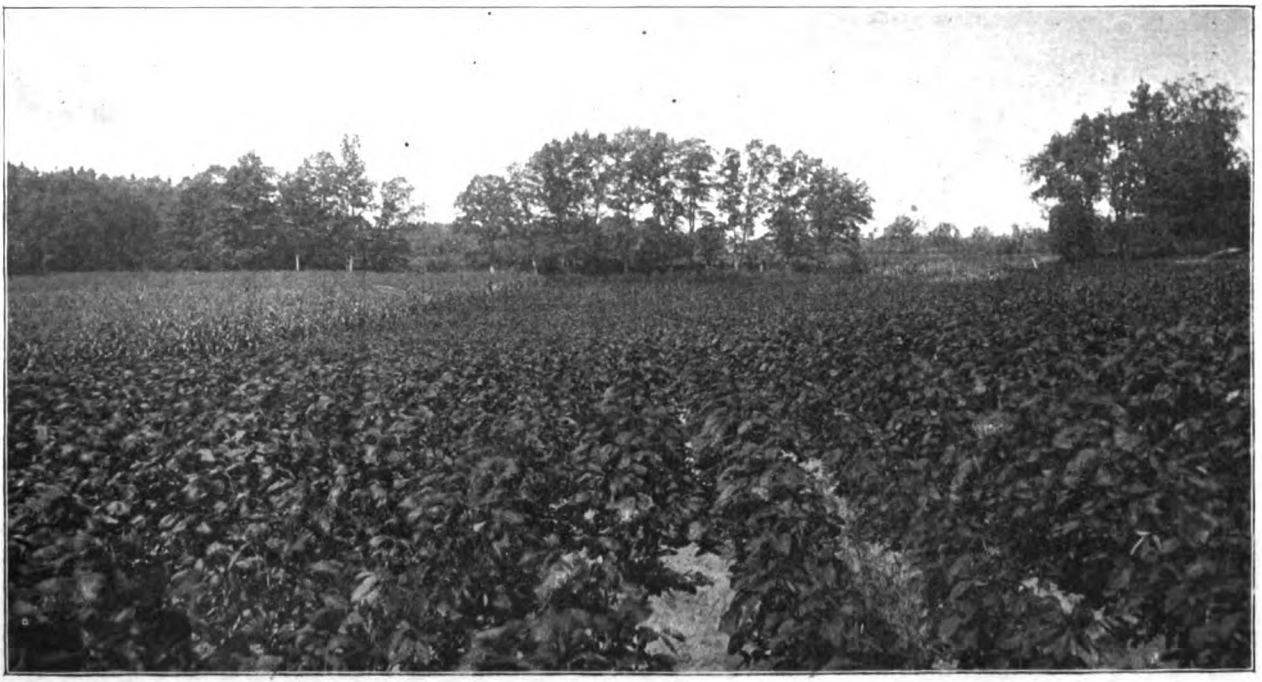


FIG. 9.—Field of late Soy Beans, 1896. College Farm. (Sanford corn on the left.)

Digitized by Google

was cut into the silo. In 1896, about two and one-half acres were grown, a photograph of which is shown in Fig. 9. This was in blossom when cut into the silo, being of the late variety. During 1897 and 1898, a fair-sized area, besides small variety test plots, has been grown. Fig. 10 contains a specimen of each of the early, medium, and late varieties, taken in September of the present season, and represents their various degrees of development. No. 1 is dead ripe, with leaves fallen; it contains, on an average, from 40 to 75 bean pods, with from 2 to 3 beans each. No. 2 is the medium early variety, and, although green when harvested, the seed was matured. No. 3 is the late variety, and although of good size, it was still in blossom when photographed.

The average yield of each variety per acre, when grown upon a fairly rich, clay loam, although poorly drained, was, for the early, No. 1, 2 tons, 1,808 pounds; for the medium-early, No. 2, 4 tons, 1,922 pounds; and for the late, No. 3, 4 tons, 1,680 pounds. The seed of the early is brown, while that of the medium-early is black. All things considered, the medium-early variety is the best, on account of its maturing a large quantity of seed as well as making a fine leafy growth, thus enabling one either to sell the seed, or convert the whole into silage. When the crop is to be cured for hay, it should be cut when in blossom. Cows eat it, but do not seem to relish it much. It is always advisable to feed it with fodder corn, millets, etc., when used for soiling. Likewise when mixed with corn for ensilage, it forms a very valuable concentrated food. Our experience has been that, when cut into the silo, the chief objection is its woody, indigestible stem.

The seed in all instances, with the exception of one experiment this present season, has been sown in drills three feet apart, with seed dropped one foot apart in the row, which requires about one-half bushel per acre. The method of cultivation was exactly the same as that given corn.

The idea that this plant will grow equally well on wornout soils, without fertilizer, is an erroneous one. It is necessary to either fertilize the land, or use soil in good heart already, if an average crop is expected. Potash, phosphoric acid, and lime

Digitized by Google

FIG. 10.—Soy Beans, 1898.

1. Early. 2. Medium 3. Late.

are recommended as the fertilizers best adapted to its growth, but we find that nitrogen is equally beneficial, especially when no turf is plowed under. In an experiment for testing this, four formulas were used; two recommended by the Massachusetts Station, one by the Delaware Station, and the fourth compounded by ourselves. One-fourth acre plots were used. The following is the composition of the fertilizers used per acre:

No. 1 (Mass.), 10,000 lbs. manure; 125 lbs. sulphate potash; 200 lbs. dissolved bone black.

No. 2 (Mass.), 320 lbs. nitrate soda; 275 lbs. muriate potash; 550 lbs. dissolved bone black.

Digitized by Google

No. 3 (Del.), 160 lbs. nitrate soda; 160 lbs. muriate potash; 400 lbs. dissolved bone black.

No. 4 (N. H.), 125 lbs. nitrate soda; 275 lbs. muriate potash; 200 lbs. dissolved bone black; 250 lbs. ground bone.

The field used was in cultivation with corn the previous season. The yield per acre was as follows:

Plot No. 1 = 5 tons, 1,157 lbs.; No. 2 = 6 tons, 1,608 lbs.; No. 3 = 4 tons, 1,720 lbs.; No. 4 = 4 tons, 262 lbs.

The following season, the same fertilizers were used on land with a comparatively heavy, old grass sod, plowed for the first time in a number of years. The yields were as follows: Plot No. 1, 1 ton, 952 pounds; No. 2, 2 tons, 608 pounds; No. 3, 4 tons, 256 pounds; No. 4, 3 tons, 1,160 pounds.

In an experiment carried on the past season in reference to seed sown in drills and broadcast, there was a yield of 5 tons, 400 pounds, as against 2 tons, 1,200 pounds in favor of the broadcast method. It must be said, however, that the beans in rows did not receive the cultivation usually given, and that both plots were not sown until June 15th. When sowing broadcast, use from one to two pecks more seed per acre.

From our experience thus far, we do not advise farmers to go into raising the Soy bean on a very extensive scale, until its value as a food has been more thoroughly demonstrated. It has not come up to our expectations. The land, of course, may not be adapted to it. However, taking into consideration the facts that its yield is so small compared with corn; that it requires fully the same amount of cultivation and labor in handling, though it is less bulky in harvesting; that it is not relished by cattle, and that there is more or less indigestible matter in the woody stem, we are not prepared to recommend it until we have had further experience with it.

THE COW PEA (*Dolichos etang*)

This plant is grown very commonly in the South, and is considered there as one of the plants best adapted to green manuring. Like the Soy bean, it is a leguminous plant; hence, a nitrogen gatherer, composed of valuable plant food. If, as is

Digitized by Google

shown from experiments, this plant is so valuable in bringing up the fertility of land in one section, why should it not be of equal value in another?

The cow pea has been grown now for two seasons. The trial plots have been on a fairly rich, clay loam, although poorly drained. The seed was planted in rows three feet apart, and from four to six inches apart in the row, which is at the rate of about one bushel per acre. When sown broadcast, one and one-half bushels are necessary. The following varieties have been grown:

Whippoorwill	Ga. Exp't Station	8 tons, 133⅓ lbs. per A.
Whippoorwill	Breck & Sons	15 tons, 976 lbs. per A.
New Era	Ga. Exp't Station	12 tons, 684 lbs. per A.
Southern Yellow Eye	Breck & Sons	18 tons, 300 lbs. per A.
Clay or Wonder	Breck & Sons	14 tons, 1,040 lbs. per A.
Southern Black Eye	Johnson & Stokes	15 tons, 1,460 lbs. per A.

The plant is of a running nature, and in a short time completely covers the ground, whether sown in drills or broadcast. It is, consequently, a troublesome crop to turn under. As a soiling and silo crop, it does not seem to be a success; the cattle do not take to it as freely even as to the Soy bean. Its main value seems to be as a green manure. Besides the plots already mentioned, two other tests are under trial. During the season of 1897, a small, triangular field of comparatively poor soil was planted, which yielded at the rate of 6 tons, 1,649 pounds per acre. This was plowed under and the ground stocked down to grass in the fall. The grass winter-killed. The ground was wet until late, so that the results will be untrustworthy until another season. This year, another good-sized plot of similar conditions was sown with cow peas, and although late when planted, they have produced at the rate of 6 tons of green material per acre.

It is thought by the writer that this crop should be given more consideration, from the facts that it is so easily grown, yields so heavily, and seems to adapt itself to comparatively poor soils. When plowing under in the fall of 1897, the roots

Digitized by Google

were found to be well covered with tubercles, being in some instances as large as hickory nuts. The plants rarely grow over 2½ feet in height, averaging usually about 2 feet.

RUSSIAN VETCH (*Vicia villosa*)

This plant has been grown at the Station in small plots during the past three years. The seed resembles that of the pea, but is much smaller, being about the size of ordinary buckwheat, only round. The plant is a legume, and therefore, like clover, is valuable as a nitrogen gatherer. The United States Department of Agriculture introduced the seed into this country, in 1886, from Russia. The seed is sown in this climate usually during May or early June for summer forage, and during August for winter forage, at the rate of 1½ bushels per acre. The plant is said to have been tested in all parts of this country, and found to be both hardy and drought-resisting.

A plot was sown to vetch the fore part of June the present season, and the crop was not cut until the middle of September, at which time the plants stood on an average 20 inches high and were very thickly matted. When cut, it averaged in the green state at the rate of 13 tons, 1,588 pounds per acre. The soil was a fairly rich loam. The natural tendency of the plants to mat thickly renders it a hard crop to harvest or to plow under as a green manure. When some erect-growing crop is grown with it, it stands up better. This was evident when the seed was sown broadcast and weeds came up, helping to hold up the vetch. It doubtless would do much better if sown like peas with oats. Vetch is being tested in other places in the state, and doubtless will be more commonly known in the near future.

OATS AND CANADA PEAS

Neither oats nor peas, when planted by themselves, give sufficient weight to make them valuable as forage crops, but when sown together, they produce a fairly heavy yield of valuable fodder. The yield per acre varies according to the ground used and its state of fertility. Our custom has been to sow them in early spring, utilizing them for soiling until they are matured

Digitized by Google

sufficiently for hay, which is usually the latter part of July. Then the remainder of the field is cut and cured. The amount of seed for best results is, we believe, 1 bushel of peas to 1 ¼ of oats. The peas should be well covered, and the oats sown

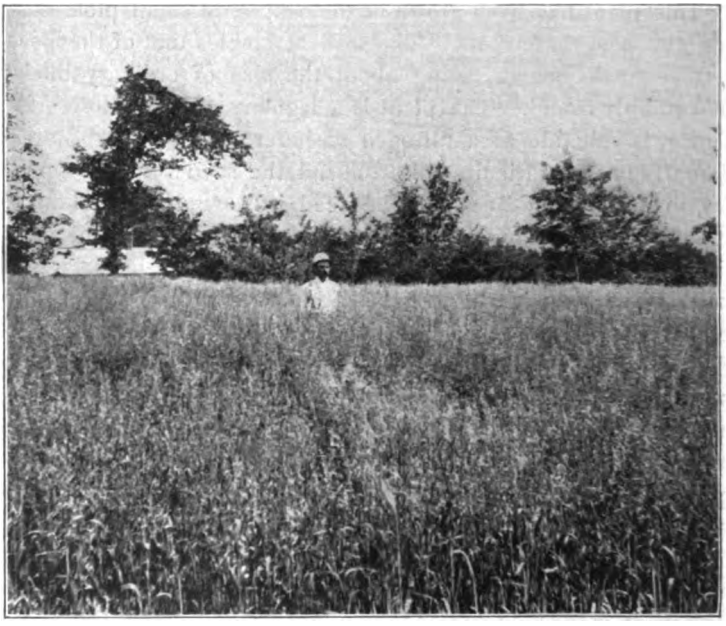


FIG. 11.—Oats and peas, 1896, College farm.

broadcast and brushed in afterward. Coming off early, as they do, a second crop can easily be grown upon the same land. Fig. 11 is a photograph of a crop of oats and peas grown on the College farm in 1896.

The fertilizer commonly used by us is 170 pounds dissolved bone black, 170 pounds ground bone, 210 pounds muriate of potash, 45 pounds dried blood, and 45 pounds nitrate of soda per acre. Anywhere from 2½ to 4 tons of green forage is an average crop under ordinary conditions. The pea belongs to the leguminous plants, and like them contains a high percentage of plant food, which constitutes its value.

Digitized by Google

CRIMSON CLOVER (*Trifolium incarnatum*)

This species of clover has received the attention of the Station throughout the past three years, and has already been reported upon in Bulletin No. 37, July, 1896. Our experience with it has been such as to lead us to discard it. It doubtless would be valuable where the climate is milder and more favorable for its growth, but in New Hampshire, we believe it has little value, as compared with other plants. A report on sowing the seed at various times throughout the year will appear in the Annual Report of this year.

LUPINE (*Lupinus albus*)

The white variety of lupine has been grown for the past two years. As it readily matures, when sown in early spring it usually is ready to turn under as a green manure in early August. This crop is used to quite an extent in Europe for this purpose. The plants grow on an average 2 feet, 4 inches high with us, and when allowed to ripen, their fruit produce at the rate of from two to three pods, containing four beans each, per plant. The seeds contain a bitter alkaloid, which is injurious to animals in the crude state. In Europe, this objectionable feature is overcome by soaking them for a day or two in water frequently changed, and then boiling for an hour, when the process of extraction, through stirring and changing the water, is again carried on for two days longer. After this process, the residue, which is now relieved of the alkaloid, makes a highly nitrogenous food, and is fed at the rate of five pounds a day per 1,000 pounds live weight.

The seeds are about the size of Lima beans. We sowed them in rows, 3 feet apart, and cultivated between the rows, but they doubtless would do well, and perhaps give a heavier yield if sown broadcast. There are two other varieties, which are more commonly in use,—the yellow and blue lupines. Our soil was heavier than that for which they are recommended; they should be grown upon light, rather sandy soils, where they are said to make a rapid growth. Belonging as they do to the leguminous order, they enrich the soil in nitrogen besides add-

Digitized by Google

ing organic matter. It naturally follows that when the crop has been turned under and as soon as decomposition begins to set in, another crop should be planted, in order to derive all the benefits from it.

SERADELLA (*Ornithopus sativus*)

This is a leguminous crop adapted to both forage and green manuring. It did not make a strong enough growth when sown by itself to ensure a crop. We have not tested it with a protective crop, but think it may have value when handled as ordinary red clover. It does best like the lupine on sandy soils, but does not contain the objectionable alkaloid ingredient found in the lupine.

SAINFOIN (*Onobrychis sativa*)

The claims for this plant are that it can be grown on dry and calcareous soils which are too barren for clovers. It is said not to thrive upon low, wet, or marshy land. Mr. Jared G. Smith writes: "There is no better plant for growing on barren hills, but it does better on the sunny slopes than those facing north. It is difficult to establish, as the plants are easily killed when young, but when well-rooted, sainfoin will live from twenty to twenty-five years, or sometimes a hundred years, provided the soil is rich enough."

In Europe one crop a year is cut which averages about the same as our ordinary hay crop. The actual food value of sainfoin is higher than that of clover. The crop is not adapted for pasturing, as it is said not to have the recuperative quality of the clovers. Like many of the legumes it is deep-rooting and also is a perennial. Our plot was very backward and hard to establish. The seed doubtless was old as but a small percentage germinated. The seed loses its vitality readily, and should be fresh, if possible, each year. Eighty pounds per acre are recommended for a sowing of unshelled and forty pounds of shelled seed, and it should be covered deeply to ensure germination. The seed is sown in early spring and the crop is harvested when in blossom. Our soil does not seem to be adapted to it, but doubtless there is land in the state where it could be

Digitized by Google

utilized to great advantage. The United States Department of Agriculture tells us that it can be grown anywhere within the United States.

C.—*Miscellaneous Forage Crops*

RAPE

This plant has been grown and fed to sheep very commonly in Canada. On a good-sized plot it made a very heavy growth here in 1896. We found, however, that it was seeded too thickly. Where the plants were given more room, as at the outer edges of the plot, they grew much more luxuriantly. During the past season a plot sown in June and not cut until September gave a yield at the rate of nearly 50 tons to the acre. It is advisable of course to feed it before the stem gets too woody. The rape can be used as a catch crop and sown any time up until late summer. If cut early it sprouts up and produces a second and sometimes a third cutting. The plant belongs to the cabbage and kale tribe, and therefore can withstand a light frost, which makes it useful at the latter end of the season as a forage crop. However, it runs out the land quickly, and therefore must be considered as a ravenous feeder. The variety commonly grown is the Dwarf Essex. It was, however, the Dwarf Victoria that gave the heavy yield this past season.

KALE

This belongs to the same family of plants as the cabbage, turnips, rape, etc. Like them it is a plant adapted for feeding purposes and withstands a low degree of temperature. The part sought for is the leaves, which are very numerous, usually curly and thick. This plant is used for greens as well as for stock. Like rape it produces a large crop and is a heavy feeder. The variety grown at the Station was the Thousand-headed kale, which was sown in the spring and cut in August, yielding at the rate of 47,432 pounds per acre. When grown in the garden, it is started in seed beds or trays and transplanted the same as cabbage or cauliflower.

Digitized by Google

SPURRY (*Spergula maxima*)

A large plot was sown to spurry three years ago, when it thickly covered the ground with a fluffy, light crop of forage. It reached a height in the tallest spots of two feet but averaged nearer one foot. The seed germinates immediately upon being sown but the plants grow rather slowly. It belongs to the pink family and is adapted to sandy soils. The second year it seeded itself, and made about the same growth as the year before. It did not make sufficient growth to be considered of value. Upon much lighter soils, however, it is claimed to be valuable.

THE SUNFLOWER

In recent years the sunflower has rapidly become a crop of recognized value. It is grown by a few at present in New Hampshire as a food for fowls. As many inquiries in regard to the culture of the crop have been made, we give the following data, from three varieties of Russian sunflowers grown here during the past two seasons. The seeds were planted in rows three feet apart and one foot apart in the row. The large Russian variety (Henderson) averaged from 6 to 10 feet high and produced a large head. The heads alone of this variety, when harvested, produced at the rate of 11 tons, 1,958 pounds per acre. The other two varieties are the so-called White Russian and the Grey Russian, both of which were sent out by the United States Department of Agriculture. The former averaged from 4½ to 6 feet in height and the heads yielded at the rate of 9 tons, 1,360 pounds per acre; while the Grey variety averaged from 5 to 7 feet in height, producing at the rate of 10 tons, 812 pounds per acre.

Considering this heavy yield and the fact that the seed contains a large percentage of highly concentrated food, there can be little question as to its value when properly fed in connection with other more succulent foods. It is believed more use should be made of this plant. The culture ordinarily given corn answers equally well for sunflowers.

Digitized by Google

IDAHO FIELD OR COFFEE PEA

Seed of this plant was sent us by the Barteldes Seed Company. A plot 9x10 feet was sown in the spring of 1896, which produced plants 2 feet, 4 inches in height by September. The plant sent out a flower which developed into a pea-pod from ¾ to 1 inch long, at the base of each leaf. As the pods of the older leaves formed, the plant continued growing and flowering, making fruit and flowers on the same plant. The plot weighed in the green state, 35 pounds, or at the rate of 8 tons, 940 pounds per acre.

SACALINE (*Polygonum sachalinense*)

This plant has caused as much sensation as a new forage crop for the last few years as any of the so-called new introductions. It is not, however, as valuable as it was first claimed to be. We began testing it in the spring of 1896. The seed was first sown in trays in the greenhouse about the first of March and when the ground outside was in good condition to receive them, the seedlings were transplanted into rows three feet apart and the

FIG. 12.—Sacaline. (First season's growth from transplanted seedling.) Height 2 feet.

Digitized by Google

plants set eighteen inches apart in the row. One-fourth of an acre was transplanted. The following September the plants had attained a height of about two feet. Fig. 12 is a photograph taken at that time and shows the results of one season's growth. At this time the main stems were very fibrous and woody and therefore very indigestible. If used for forage it is necessary to cut them often. Our cattle ate the succulent part readily. The following spring not over one-twentieth of them were alive; they heaved badly, being of such a large root growth. The soil too was a clay loam. Even those that did live seemed to be affected by the severe winter and made a rather indifferent growth the next season, not reaching over four and one-half feet in height. They were given no care and have at the present writing all disappeared. If planted in light ground we believe the results would be much better. They are very vigorous growers and when once established in a suitable climate, we believe they would make considerable forage, and in fact be a very troublesome plant to eradicate. To grow them from seed sown in the field is a discouraging undertaking. On the other hand, twenty-five cents per plant is too expensive should a person desire to test them. They are easily grown under glass or indoors at a window. Like many other of the novelties, they may do well where drouths and forage famines are frequent; but where corn and other suitable crops are so readily grown, we believe there is no use for them.

GIANT BEGGAR WEED

This plant was grown during the past season in a plot 9x10 feet. The seed was sown in early spring. At the end of the season the largest of the plants stood 4½ feet in height and each had branched, closely to the ground into from seven to nine main shoots, thus making a large head. The leaf resembles the cow pea in general shape and appearance. The main stems of the plant, like the sacaline, become very fibrous when allowed to grow beyond the succulent stage. The claims for the plant are its adaptability to poor soils and its highly nutritious food value as a forage crop. It is thought to be of special value for the South. We doubt its value for New Hamp-

Digitized by Google

shire unless it can be made to grow upon land now entirely worthless.

II.—ROOT CROPS

During the past three years root crops have been grown to a limited extent and fed to the College herd. They have been replaced by ensilage in most sections in late years, and while this has been to the advantage of farmers generally, we must not forget that roots have their value. It often happens that roots can be used to advantage as a catch crop; also, that land under certain rotations would yield a crop of roots with relatively little loss of plant food. Even where ensilage is commonly the succulent food, every herd has its complement of dry cows, young stock, and bulls that will utilize the roots to advantage. They can readily be shifted from one place of feeding to another, the only thing necessary being to keep them from freezing.

As compared with ensilage corn, roots are more troublesome to raise for the general farmer, for where cultivation with comparatively little hand-hoeing is required with the former, with roots hand-hoeing and weeding are important problems. Under the best conditions as much digestible dry matter can be raised per acre with roots as with ensilage corn. The problem is mainly one for the individual to settle, as the nature of the soil, conveniences for handling, the animals to be fed, etc., are all-important factors. Doubtless a person who leans toward gardening will make better success with root crops than one more interested in general farming, as they need the care and attention the former would give.

Wohauka Sugar Beet.—Two varieties, Nos. 1 and 2, the seed of which was sent us by the Austrian government, have been grown at the Station. They yielded on an average 9 tons, 880 pounds per acre. These varieties are both shown in Fig. 13.

Mammoth Long Red Mangel-Wurzel, Fig. 13.—This is a long, red, smooth-skinned variety, of large size, and a heavy yielder. In 1896 under ordinary culture it produced 17 tons, 880 pounds.

Digitized by Google

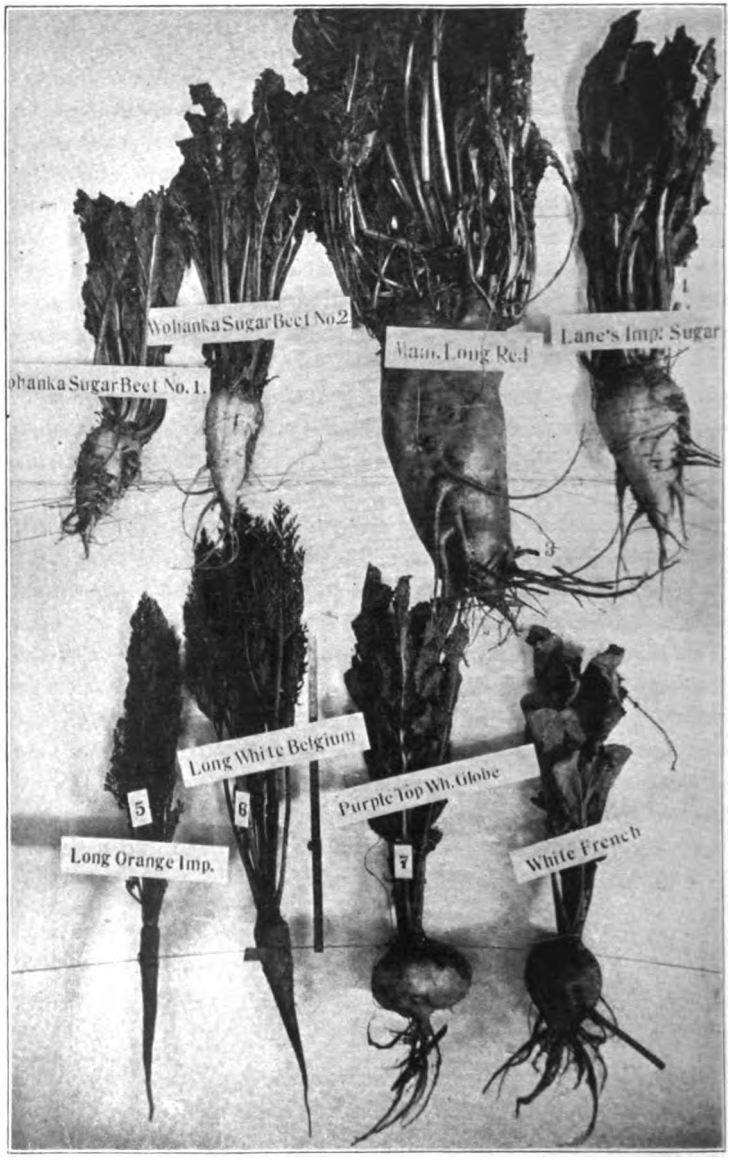


FIG. 13.—Root Crops.

Digitized by Google

Lane's Improved Sugar Beet, Fig. 13.—A well-known and commonly-grown cattle beet. Yield per acre, 11 tons, 560 pounds.

Long Orange Improved Carrot, Fig. 13.—This variety as its name implies is very long and slender and can be used for either the table or for stock. Its yield was only 4 tons, 1,920 pounds per acre.

Large White Belgian Carrot, Fig. 13.—This is considered one of the most profitable for feeding stock. The yield per acre was 9 tons, 880 pounds.

Purple Top White Globe Turnip, Fig. 13.—A large, round variety, grown for table use as well as for stock. Yield, 12 tons per acre.

White French Rutabaga, Fig. 13.—This is a fine stock variety; also can be utilized for the table. Firm, white, and solid. In 1896 it produced at the rate of 25 tons, 1,200 pounds per acre.

Skirving's Purple Top Rutabaga.—During the past season this variety was grown on quite a large area, and gave a very fair yield. It resembles the Purple Top White Globe. Large, yellow, firm, and a good keeper.

	Yield per acre.	Yield of dry matter per acre.	Yield of digestible matter per acre.
	Lbs.	Lbs.	Lbs.
Sugar Beets, No. 1	18,880	2,772	2,615
Mangolds, L'g red cattle	34,880	3,681	2,898
Sugar Beet, Lane's Imp	22,560	3,313	3,125
Turnip, Purple top Wh. Globe	24,000	2,586	2,255
Rutabagas, White French	51,200	5,517	4,833
Ensilage Corn (average)	30,000	7,500	

Digitized by Google

The root crops are so largely composed of water that one gets a very vague idea of the real dry matter from the total weight per acre. In order that this may be compared with the dry matter of ensilage, which is usually estimated as being one-fourth, or 25 per cent., I have computed the accompanying table. Besides giving the total dry matter, it also contains the digestible dry matter. These computations are based upon the chemical analyses of the Maine Station, which it is thought answer equally well for our conditions.

FIG. 14.—Jerusalem Artichoke. Height 5 feet.

Jerusalem Artichoke.— This plant is grown for the fleshy tubers which form about the roots just beneath the surface of the soil. They are the only parts used for propagation and in this respect the plant resembles the potato. They are very irregular in outline, being about 2½ inches long and half as thick, usually tapering at both ends. The eyes unlike those of the potato protrude, producing more or less of a knobby appearance. The roots or tubers are cut to single eye cuttings, and planted usually in rows three feet apart and two feet apart in the row. Three bushels of roots are

Digitized by Google

enough to plant an acre of ground. Cover the seed about two inches deep. Fig. 14 is a plant photographed in October of 1896, representing the growth of one season. Its height was 5 feet and it contained 15 tubers.

This crop is commonly recommended as being adapted for feeding hogs; the animals are turned into the field and allowed to do their own digging. The tubers are not very deep and therefore accessible. The large percentage of starch contained in them makes them a valuable food. They may be dug and fed the same as other roots.

A very interesting pamphlet setting forth the value of the Jerusalem Artichoke, was sent to the Station about a year ago, which recommended, besides utilizing the tubers, the making of silage out of the tops. We have not yet tried this. This plant is a favorite food of the woodchuck, which persists in eating down the top, especially in early summer. Under certain conditions doubtless this plant can be used to advantage.

REMARK

As there are so many crops treated and each as briefly as possible, a table of contents is given in the fore part of this Bulletin, which is to take the place of the usual summary.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 58 October 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

The Cost of Raising Calves

THE EXPERIMENT STATION BUILDING

By FRED W. MORSE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D , *Acting Director*.
FRED W. MORSE, B. S., *Vice-Director and Chemist*.
CHARLES H. PETTEE, A. M., C. E., *Meteorologist*.
HERBERT H. LAMSON, M. D., *Bacteriologist*.
CLARENCE M. WEED, D. Sc., *Entomologist*.
FRANK WM. RANE, B. AGR., M. S., *Horticulturist*.
CHARLES W. BURKETT, M. S., *Agriculturist*.

BULLETINS OF 1898

Bulletin 49—Inspection of Fertilizers. January.
Bulletin 50—Dehorning Cattle. February.
Bulletin 51—Sweet Corn in New Hampshire. March.
Bulletin 52—Growing Muskmelons in the North. April.
Bulletin 53—The Farm Water Supply. May.
Bulletin 54—The Winter Food of the Chickadee. June.
Bulletin 55—The Feeding Habits of the Chipping Sparrow. July.
Bulletin 56—Poisonous Properties of Wild Cherry Leaves. August.
Bulletin 57—Forage Crops. September.

Digitized by Google

THE COST OF RAISING CALVES

BY FRED W. MORSE

During portions of 1897 and 1898 careful records were kept of the amount of food consumed by several calves and yearlings for the purpose of securing data from which to calculate the cost of raising a dairy cow. In addition to our own data, we have collected and compared all similar figures to be found in the bulletins of the American experiment stations. This bulletin is written in order to give the farmers of New Hampshire as close an approximation as possible to the probable cost of raising heifer calves to the age of sixteen months. It is planned to continue the work, and in the future, issue another bulletin giving the cost up to the stage of growth at which the animal will pay her own expenses.

The general method of feeding calves, during the periods mentioned in this bulletin, was as follows:

The calf was taken from the cow as soon as the latter's milk was fit for creamery use. It was first fed with whole milk, which was gradually replaced by skim-milk, until by the end of the second week of growth it received only milk that had been run through the separator, and was almost completely free from fat. To replace the fat, a mixture of ground flax-seed, cooked in water, was added to the milk. The proportions in this mixture were one pound of flax-seed to four quarts of water, making a thick mucilaginous jelly, which could be readily mixed with the milk. The calves were fed from seven to ten quarts of skim-milk and one or two quarts of flax-seed jelly, daily, in two feeds. During part of the time middlings were cooked instead of flax-seed. As soon as possible the animals were encouraged to eat grain and hay, and the increase in food made necessary by gain in size and weight, consisted of these materials, while the skim-milk and flax-seed remained nearly constant in amount as long as they were used, which was up

Digitized by Google

to the age of six to eight months, or until the animals' first season in the pasture. Some of the calves were taught to drink from a pail; but most of them were given their milk through Small's calf feeder, since it made the work of feeding much less.

Careful watch was maintained to note any indigestion; therefore diarrhœa or "scouring" was quickly stopped by reducing the quantity of food and adding lime-water to the milk. Little difficulty was experienced in keeping up a steady growth in size and gain in weight. Differences were always noticeable between individual animals in the rate of growth and amount of food consumed. Large animals invariably required more food to maintain their condition than small ones.

The quantities of food consumed, and cost of the same, together with the breeds, ages, weights, and weekly gains are given in the following tables, which for convenience are arranged to show six successive stages of growth. The records include thirteen individual animals, and all seasons of the year.

In calculating the cost of the food consumed by the animals, the following scale of prices was adopted as representing a fair approximation to actual prices at various seasons of the year:

	Per 100 lbs.
Milk	$1.00
Skim-milk	.20
Flax-seed	3.25
Middlings	.80
Bran	.70
Linseed	1.25
Oats	1.00
Oatena	.65
Mixed grain (2 parts middlings, 2 parts oat-feed, 1 part linseed)	.90
Hay	.50
Green barley fodder	.15

The different breeds are indicated by the abbreviations, J, Jersey; J. G., Jersey grade; H. G., Holstein grade; A., Ayrshire; D., Durham; D. G., Durham grade, and Gy., Guernsey.

Digitized by Google

COST OF FEEDING CALVES.—CALVES UNDER FIVE WEEKS OLD.

No. of calf.	Breed.	Weight at beginning.	Length of period, in weeks.	Weight at end.	Ave'ge weekly gain.	Kinds and quantities of food consumed. Whole period.	Total cost of food.	Ave'ge weekly cost of food.
		Lbs.		*Lbs.*	*Lbs.*	*Quantity in pounds.*		
6	H. G.	92	May 3 to June 5, '97, 33.....	130	8	36 milk, 516 skim-milk, 9½ flax-seed, 19 oats	$1.89	$.40
7	J.	64	Aug. 21 to Sept. 18, '97, 28....	92	7	24 milk, 424 skim-milk, 6¼ flaxseed.....	1.29	.323
8	J. G.	79	Sept. 4 to Oct. 2, '97, 28.....	102	5.75	112 milk, 784 skim-milk, 14 flax-seed.....	3.14	.785
9	D. G.	86		115	7.25			
10	A. & D.	100	Sept. 4 to Oct. 2, '97, 28.....	130	7.5	70 milk, 490 skim-milk, 5¼ flax-seed, 7 middlings.....	1.90	.475
11	A.	86	Nov. 30, '97, to Jan. 1, '98, 32..	128	9.2	90 milk, 438 skim-milk, 8 flax-seed, 2 linseed, 7 hay.....	2.09	.457
12	J. G.	70	Dec. 7, '97, to Jan. 1, '98, 25..	95	7	54 milk, 372 skim-milk, 7¾ flax-seed.....	1.53	.428
13	A.	72	Dec. 11, '97, to Jan. 8, '98, 28.	100	7	64 milk, 356 skim-milk, 5¼ flax-seed, 1 linseed.....	1.53	.383
			FROM FIVE TO NINE WEEKS OLD.					
6	H. G.	130	June 5 to July 3, '97, 28.....	174	11	504 skim-milk, 10 flax-seed, 44 oats, 21 middlings, 42 hay	2.15	.538
7	J.	92	Sept. 18 to Oct. 16, '97, 28....	122	7.5	406 skim-milk, 1¾ flax-seed, 28 mixed grain.....	1.11	.278
8	J. G.	102	Oct. 2 to Oct. 30, '97, 28.....	137	8.75	896 skim-milk, 14 flax-seed, 42 middlings, 21 hay.....	2.40	.60
9	D. G.	115		159	11			
10	A. & D.	130	Oct. 2 to Oct. 30, '97, 28.....	176	11.5	560 skim-milk, 5¼ flax-seed, 28 middlings, 10 hay.....	1.56	.39
11	A.	128	Jan. 1 to Jan. 29, '98, 28.....	165	9.25	448 skim-milk, 10½ flax-seed, 3½ middlings, 48 bran, 4 linseed, 33 hay.....	1.81	.453
12	J. G.	95	Jan. 1 to Jan. 29, '98, 28.....	124	7.25	448 skim-milk, 10½ flax-seed, 3½ middlings, 4 linseed, 21 hay...	1.42	.38
13	A.	100	Jan. 8 to Feb. 5, '98, 28.....	126	6.5	448 skim-milk, 3½ flax-seed, 7 middlings, 3½ linseed, 28 hay....	1.22	.305

Digitized by Google

COST OF FEEDING CALVES.—NINE TO THIRTEEN WEEKS OLD.

No. of calf.	Breed.	Weight at beginning.	Length of period, in w'ks.	Weight at end.	Ave'ge weekly gain.	Kinds and quantities of food consumed. Whole period.	Total cost of food.	Ave'ge weekly cost of food.
		Lbs.		*Lbs.*	*Lbs.*	*Quantities in pounds.*		
5	Gy.	129	May 8 to June 5, '97, 4.....	176	11.75	468 skim-milk, 14 flax-seed, 41 oats, 1 linseed, 18 hay.....	$1.90	$.475
7	J.	122	Oct. 16 to Nov. 13, '97, 4.....	170	12	392 skim-milk, 7 flax-seed, 45¼ middlings, 2 linseed, 3¼ hay....	1.36	.34
8	J. G.	137	Oct. 30 to Nov. 27, '97, 4.....	185	12	896 skim-milk, 14 flax-seed, 126 middlings, 8 linseed, 126 hay..	3.96	.995
9	D. G.	159		205	11.5			
10	A. & D.	176	Oct. 30 to Nov. 27, '97, 4.....	240	16	560 skim-milk, 7 flax-seed, 63 middlings, 4 linseed, 63 hay.....	2 21	.553
11	A.	165	Jan. 30 to Feb. 27, '98, 4.....	205	10	448 skim-milk, 2 flax-seed, 68 middlings, 49 hay.....	1.75	.437
12	J. G.	124	Jan. 30 to Feb. 27, '98, 4.....	171	11.75	448 skim-milk, 2 flax-seed, 19 middlings, 28 hay...	1.25	.313
13	A.	126	Feb. 5 to March 5, '98, 4.....	165	9.75	448 skim-milk, 3 flax-seed, 25 middlings, 28 hay.....	1.33	.333
			THIRTEEN TO TWENTY WEEKS OLD.					
6	H. G.	201	July 31 to Aug. 28, '97, 4.....	213	10.5	504 skim-milk, 84 mixed grain, 84 hay.....	2.18	.545
7	J.	170	Nov. 13 to Dec. 25, '97, 6.....	232	10.3	616 skim-milk, 16 flax-seed, 47 middlings, 42 oatena, 6 linseed, 126 hay.....	3.10	.516
8	J. G.	185		245	10			
9	D. G.	205	Nov. 27, '97, to Jan. 8, '98, 6..	268	10.5	1,344 skim-milk, 38½ flax-seed, 87 middlings, 84 oatena, 12 linseed, 252 hay.....	6.58	1.096
10	A. & D.	240	Nov. 27, '97, to Jan. 8, '98, 6..	305	10.8	840 skim-milk, 17 flax-seed, 46 middlings, 42 oatena, 6 linseed, 126 hay.....	3.58	.596
11	A.	205	Feb. 27 to April 10, '98, 6.....	265	10	672 skim-milk, 7 flax-seed, 119 middlings, 140 hay.....	3.22	.536
12	J. G.	171	Feb. 27 to April 10, '98, 6.....	229	9.6	672 skim-milk, 7 flax-seed, 49 middlings, 168 hay..... .	2.80	.466
13	A.	165	March 5 to April 9, '98, 5....	210	9	560 skim-milk, 5 flax-seed, 53 middlings, 140 hay.....	2.40	.48

Digitized by Google

COST OF FEEDING CALVES.—FOUR TO EIGHT MONTHS OLD.

No. of calf.	Breed.	Weight at beginning.	Length of period in weeks.	Weight at end.	Ave'ge weekly gain.	Kinds and quantities of food consumed. Whole period.	Total cost of food.	Ave'ge weekly cost of food.
		Lbs.		*Lbs.*	*Lbs.*	*Quantities in pounds.*		
5	Gy.	312	Aug. 28 to Dec. 4, '97, 14.....	464	10.9	3,348 skim-milk, 818 mixed grain, 112 bran, 61 linseed, 762 hay.	$19.40	$1.385
6	H. G.	243		430	13.4			
7	J.	232	Dec. 25, '97, to Apr. 9, '98, 15.	375	9.5	1,680 skim-milk, 22 flax-seed, 233 middlings, 22 linseed, 567 hay	9.01	.60
8	J. G.	245	Jan. 8 to April 16, '98, 14.....	392	10.5	3,136 skim-milk, 31 flax-seed, 438 middlings, 32 linseed, 1,062 hay	16.59	1.185
9	D. G.	268		415	10.5			
10	A. & D.	305	Jan. 8 to April 16, '98, 14.....	475	12.1	1,960 skim-milk, 15 flax-seed, 219 middlings, 20 linseed, 541 hay	9.11	.65
						Eight to Thirteen Months Old.		
5	Gy.	464	Dec. 4, '97, to Apr. 16, '98, 19.	519	2.9	2,492 hay, 952 middlings, 112 oatena, 110 linseed.	29.17	1.166
6	H. G.	430		574	7.6			
						Thirteen to Sixteen Months Old.		
1	J. G.	570	Jan. 23 to April 16, '98, 12....	665	7.9	3,696 hay, 784 middlings, 490 bran, 70 oats, 56 linseed, 336 rowen.	31.26	2.605
2	J. G.	582		658	6.3			
3	A.	595		655	5.			
*4	J. G.	498		562	5.3			

*No. 4 was two months younger than the other heifers in the group.

Digitized by Google

SUMMARY OF TABLES

Eight calves under 5 weeks old. Average weekly gain 7.6 pounds. Average weekly cost 40.6 cents.

Eight calves from 5 to 9 weeks old. Average weekly gain 9.1 pounds. Average weekly cost 36 7 cents.

Eight calves from 9 to 13 weeks old. Average weekly gain 11.8 pounds. Average weekly cost 43.1 cents.

Eight calves from 13 to 20 weeks old. Average weekly gain 10 pounds. Average weekly cost 52.9 cents.

Six calves from 4 to 8 months old. Average weekly gain 11.1 pounds. Average weekly cost 63.7 cents.

Two calves from 8 to 13 months old. Average weekly gain 5.25 pounds. Average weekly cost 58.3 cents.

Four heifers from 13 to 16 months old. Average weekly gain 6.12 pounds. Average weekly cost 65.1 cents.

The heifers 1. 2, 3, and 4, were maintained on pasturage from July 24 until October 26, 1897, a period of 13 weeks and 2 days. The total gain in weight of the four animals was 313 pounds, or an average weekly gain of 5.9 pounds per head.

During the feeding periods recorded in the foregoing tables, comparisons were made between cooked, ground flax-seed, and cooked middlings as a substitute for the fat in milk, and also between rations including the cooked food and those without it.

In the first named trial, the calves were between 5 and 8 months old, and the middlings proved to be a satisfactory substitute for the ground flax-seed, the cost being less and the gain in weight large enough for the purpose though a little smaller than on the flax-seed.

The calves in the second trial mentioned were also over five months old. The substitution of the dry grain lessened the cost and the gain was sufficiently large, although smaller than in the previous period.

These trials show that for calves at the age of those described, there is no object in using anything but dry grain and hay along with the skim-milk, unless the greatest possible amount of growth is desired.

Digitized by Google

COMPARISON OF COOKED, GROUND FLAX-SEED WITH COOKED MIDDLINGS.

No. of Calf.	Breed.	Weight at beginning.	Length of period in days.	Weight at end.	Ave'ge weekly gain.	Kinds and quantities of food consumed.	Total cost of food.	Ave'ge weekly cost.
		Lbs.		*Lbs.*	*Lbs.*	*Quantities in pounds.*		
7	J.	212	Dec. 18, '97 to Jan. 22, '98, 35.	260	9.6	560 skim-milk, 17½ flax-seed, cooked, 70 middlings, 11 linseed, 105 hay	$2.91	$.582
8	J. G.	204	Dec. 18, '97 to Jan. 22, '98, 35.	285	12.2	1120 skim-milk, 35 flax-seed, cooked, 140 middlings, 10 linseed,		
9	D. G.	225	Dec. 18, '97 to Jan. 22, '98, 35.	277	10.4	210 hay	5.67	1.134
10	A. & D.	255	Dec. 18, '97 to Jan. 22, '98, 35.	328	14.6	700 skim-milk, 17½ flax-seed, cooked, 70 middlings, 11 linseed, 105 hay	3.19	.638
7		260	Jan. 22 to Feb. 19, '98, 28.....	300	10	448 skim-milk, 14 middlings, cooked, 56 middlings, dry, 12 linseed, 105 hay	2.13	.532
8		265	Jan. 22 to Feb. 19, '98, 28.....	305	10	896 skim-milk, 28 middlings, cooked, 112 middlings, dry, 28		
9		277	Jan. 22 to Feb. 19, '98, 28.....	315	9.5	linseed, 210 hay	4 31	1.078
10		328	Jan. 22 to Feb. 19, '98, 28....	332	13.5	560 skim-milk, 14 middlings, cooked, 56 middlings, dry, 12 linseed, 105 hay	2.35	.588

COMPARISON OF RATIONS WITH AND WITHOUT COOKED FOOD.

4	J. G.	224	May 22 to June 26, '97, 35....	287	12.6	700 skim-milk, 18 flax-seed, cooked, 70 oats, 3 linseed, 42 hay	2.93	.586
5	Gy.	146	May 22 to June 26, '97, 35....	212	12.4	630 skim-milk, 18 flax-seed, cooked, 70 oats, 3 linseed, 42 hay	2.79	.558
10	A. & D.	382	Feb. 19 to Mar. 26, '98, 35.....	443	12.2	700 skim-milk, 17½ flax-seed and middlings, cooked, 70 middlings, dry, 286 hay	3.74	.748
11	A.	190	Feb. 19 to Mar. 26, '98, 35.....	250	12.	560 skim-milk, 17½ flax-seed and middlings, cooked, 70 middlings, dry, 126 hay	2.66	.532
12	J. G.	160	Feb. 19 to Mar. 26, '98, 35.....	210	10.	560 skim-milk, 17½ flax-seed and middlings, cooked, 31½ middlings, dry, 126 hay	2.35	.47
4		287	June 26 to July 24, '97, 28....	333	11.5	560 skim-milk, 84 mixed grain, 46 hay, 7 oats, 48 green barley	2.24	.56
5		212	June 26 to July 24, '97, 28....	263	12.7	486 skim-milk, 84 mixed grain, 49 hay, 7 oats, 42 green barley	2.10	.525
10		443	Mar. 26 to Apr. 16, '98, 21.....	475	10.7	420 skim-milk, 42 middlings, 168 hay	2 01	.67
11		250	Mar. 26 to Apr. 16, '98, 21.....	277	9.	336 skim-milk, 70 middlings, 42 hay	1.44	.48
12		210	Mar. 26 to Apr. 16, '98, 21.....	244	11.3	336 skim-milk, 21 middlings, 84 hay	1.26	.42

Digitized by Google

From the experiments reported by other American experiment stations, we have taken the results obtained with heifer calves, and calculated the cost of food on the basis of the New Hampshire schedule of prices.

The Massachusetts State Experiment Station in its Annual Report, for 1893, describes an experiment with various substitutes for milk-fat, while feeding skim-milk.

Four heifers in the lot were fed during an average period of 80 days, or up to the age of 12 weeks, on whole milk, skim-milk and a variety of grain mixtures. The average weekly gain for one calf was 9.7 lbs, and the average weekly cost of food would have been 41 cents. These results are very close to our own figures for calves of the same age.

The Iowa Experiment Station, in Bulletins 14 and 19, also reports results of feeding different grains with skim-milk. In Bulletin 14, two heifers between the ages of 6 weeks and 20 weeks, one a Shorthorn and the other a Holstein, in 13 weeks, consumed each, 1,456 lbs. skim milk, 127 lbs. flax-seed, 118 lbs. grain, consisting of ground oats, ground barley, corn meal, and bran, and 166.5 lbs. hay. The average weekly gain in weight for each calf was 12.7 lbs., and the average weekly cost of food on our basis would have been 68 cents.

In Bulletin 19, six heifers between the ages of 8 and 17 weeks, consumed in 60 days, an average per head of 1,200 lbs. skim-milk and 105 lbs. of grain, either linseed-meal, ground oats, or a mixture of corn-meal and ground flax-seed, 9 parts of the former to one part of the latter.

The average gain per week was 7.7 lbs. for each calf, and the average weekly cost of food would have been 41.5 cents.

The average gain for both lots would be 9 lbs. and the average cost per week would be 48.1 cents.

The average cost of our calves during this period was 45.4 cents per week.

The Minnesota Experiment Station, in Bulletin 35, gives results obtained with 8 heifer calves from two days old up to five and one-half months. The average feeding period occupied 21 weeks. The average quantity of food consumed by one calf during this period was 132 lbs. milk, 2,118 lbs. skim-milk, 18.4 lbs. bran, 16.6 lbs. flax-seed, 25.3 lbs. oats, 4.4 lbs.

Digitized by Google

corn meal, and 40.2 lbs. hay. These calves were carefully watched and closely fed so that no fattening occurred. The average weekly cost of food for each calf would have been on our basis, 32 cents, and the average weekly gain was 8.75 lbs.

For the period covered by these experiments the average weekly cost of our calves was approximately 44.2 cents, and the average weekly gain 9.5 lbs.

At the Kansas Experiment Station, as reported in Bulletin 72, the amounts of foods consumed by a number of young animals was carefully recorded during the winter months. Two Shorthorn heifers between the ages of 7 1-2 and 9 1-2 months, fed on hay, silage and grain, made an average weekly gain of 12.4 lbs. each, and the weekly cost of food would have been on our basis 44.5 cents.

Five heifers, one Hereford, and four Jerseys, fed on hay, grain, and a few mangels, between the ages of 11 and 16 months, made an average weekly gain of 9 lbs. each, and the weekly cost of their food would have been 58 cents per head.

The cost of our calves for a similar period was 65 cents per week.

The Wisconsin Experiment Station, in its annual Report for 1886, gives the results of feeding sixteen steers and heifers in one lot. These animals between the ages of 7 and 12 months, were fed for 18 weeks on hay, corn silage, corn stover, and grain, and during this period made an average weekly gain of 6.9 lbs. per head and the weekly cost of their food would have been 48.7 cents per week.

The cost of two heifers at our station for a similar period was 58 cents per week.

To ascertain the essential causes of the higher cost of our heifers when compared with the young stock fed in Kansas and Wisconsin, whose cost was calculated after our schedule, it was found that our older lot of heifers received an average per head of 4.1 lbs. grain and 11 lbs. hay, daily, while the five Kansas heifers received an average per head of 5.5 lbs. grain, and 4.9 lbs. hay, with a little silage and mangels.

The younger lot of our heifers received an average daily ration per head of 4.4 lbs. grain and 9.3 lbs. hay while the 16 Wis-

Digitized by Google

consin animals received an average daily ration per head of 5.25 lbs. grain, 3.6 lbs. hay, 1.4 lbs. stover and 3.6 lbs. silage.

This comparison shows that our heifers were fed much more freely with hay than was necessary, which was due to the abundant crop that year. Were the schedule price of hay in this particular case, assumed to be the actual price of hay in the mow, at the time of feeding, the average cost per week would be much reduced.

The data at hand cover the period of sixteen months, and we think that a fair approximation to the actual cost of raising a heifer to that age can be calculated from them.

We will assume that a calf is dropped about October 1st.

For five months or 21 $\frac{3}{4}$ weeks, the cost according to our own data, would be 44.2 cents per week, or $9.57.

For the next three months or 13 weeks, our data would make the cost 63.7 cents per week or $8.28.

The pasture season would now be at hand and continue for five months, and the cost would vary with the location. The figures that we have obtained for calves, range between $1.50 and $2.50 for the season.

The remaining three months, would cost according to our data, 65.1 cents per week, or $8.46 for the 13 weeks. The total cost for the food consumed by the heifer during the 16 months would then be $28.81, and she should weigh from 600 to 700 lbs.

By closer feeding, as shown by the data from Kansas, Minnesota, and Wisconsin experiments, the cost should be reduced about 20 per cent., or to about $23.00.

In conclusion, a study of the tables will show that high-priced foods, viz., whole milk, flax-seed, linseed meal, and oats, will cause the cost of the weekly ration to increase out of proportion to the gain, if fed freely. Flax-seed cannot be used with economy except in the earliest stages of growth, the first two or three months, and whole milk should be discontinued as soon as possible.

The writer takes pleasure in acknowledging the assistance of Messrs. R. S. Alden, Leigh Hunt, E. H. Forristall, and H. A. Hanscom, who have at different times had charge of the work.

Digitized by Google

Sci 1636.35

Bulletin 59 November, 1898

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

TENTH ANNUAL REPORT

BY CHARLES S. MURKLAND

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION.

DURHAM, N. H.

BOARD OF CONTROL.

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHARLES S. MURKLAND, *ex officio*, Durham.

THE STATION COUNCIL.

PRES. CHARLES S. MURKLAND, A. M., PH. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
FRANK WM. RANE, B. AGR., M. S., *Horticulturist.*
CHARLES W. BURKETT, M. S., *Agriculturist.*

ASSISTANTS.

ELWIN H. FORRISTALL, B. S., *Assistant Agriculturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.**
ERNEST J. RIGGS, B. S., *Assistant Horticulturist.*†
WILLIAM F. FISKE, *Assistant Entomologist.*
CLEMENT S. MORRIS, *Clerk.*

* Resigned October 1, 1898. † Resigned June 8, 1898.

Digitized by Google

TENTH ANNUAL REPORT.

The tenth annual report of the New Hampshire College Agricultural Experiment Station, for the year ending October 31, 1898, is herewith respectfully submitted. The reports of the department will be found upon the pages indicated in the following list:

Financial statement	169
Report of the Vice-Director	171
Department of Horticulture	176
Department of Agriculture	192
Department of Bacteriology	193
Department of Entomology	199
Department of Meteorology	215

CHARLES S. MURKLAND,
Acting Director.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ending June 30, 1898.

RECEIPTS.

Cash received from United States treasurer	$15,000.00

EXPENDITURES.

Cash paid for salaries	$8,148.88
labor	1,336.22
publications	976.20
postage and stationery	136.44
freight and express	79.19
heat, light, and water	981.33
chemical supplies	172.92

Digitized by Google

Cash paid for seeds, plants, and sundry supplies	$40.27	
fertilizers	217.80	
feeding stuffs	400.17	
library	401.45	
tools, implements, and machinery	310.64	
furniture and fixtures	66.43	
scientific apparatus	621.18	
live stock	32.60	
traveling expenses	261.38	
contingent expenses	75.77	
building and repairs	741.13	
		$15,000.00

SUPPLEMENTARY STATEMENT.

Receipts.

Cash received from the State Board of Agriculture for analysis of fertilizers	$627.00

Expenditures.

Cash paid for salaries	$286.45	
Balance	340.55	
		$627.00

We, the undersigned, duly authorized auditors of the corporation, do hereby certify that we have examined the books and accounts of the New Hampshire College Experiment Station for the fiscal year ending June 30, 1898; that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by us examined and found correct.

Also, that the receipts from fertilizer analyses have been duly expended and vouched for, as per supplementary statement.

Digitized by Google

And we further certify that the expenditures have been solely for the purposes set forth in the act of congress approved March 2, 1887.

(Signed)
JOHN G. TALLANT,
CHARLES S. MURKLAND,
Auditors.

Durham, N. H.

REPORT OF THE VICE-DIRECTOR.

To Charles S. Murkland, Acting Director:

The work of the Agricultural Experiment Station during the year ending October 31, 1898, has been conducted with no drawbacks excepting the wet spring season, which prevented the execution of some field experiments by delaying the preparation of the land until too late to secure satisfactory results.

Two important changes have been made in the policy and organization of the station.

At the beginning of the year, in accordance with the vote of the Board of Control, the college farm, herd, and creamery were made financially independent of the experiment station, while remaining under the same management as last year; and field experiments were limited to definite areas, instead of being conducted in every field that was tilled. By this means the items for labor, food-stuffs, and tools charged to the Hatch fund have been much reduced, while the supplementary statement no longer contains credits for farm produce sold.

On September 15, the Department of Agriculture and Horticulture was divided into two distinct departments, Professor Rane remaining at the head of the Department of Horticulture and Associate Professor Burkett assuming charge of the Department of Agriculture. The step is too recent to affect the work of this year.

Digitized by Google

The following changes have occurred in the staff of the station:

January 1, Mr. Ernest J. Riggs, B. S., of Ohio, was appointed assistant horticulturist, and continued in that position until June 8, when he resigned in order to return to Ohio.

July 1, Mr. Charles W. Burkett, M. S., of Ohio, was appointed assistant agriculturist, and on September 15 became head of his department.

October 1, Mr. Charles D. Howard, B. S., resigned his position as assistant chemist to accept a better position at the West Virginia Experiment Station.

Several important improvements have been made in the buildings, three fourths of the cost of which was borne by the farm. These improvements include stalls and pens for young cattle and calves in the new stable, a cement floor in the manure cellar under it, and a wash-room adjoining it. A small stable containing three stalls was fitted up in the old barn for experimental use.

The bulletins prepared during the year are as follows:

No. 49. Inspection of Fertilizers. By Fred W. Morse.

No. 50. Dehorning Cattle. By F. Wm. Rane and H. H. Lamson.

No. 51. Sweet Corn for New Hampshire. By F. Wm. Rane.

No. 52. Growing Muskmelons in the North. By F. Wm. Rane.

No. 53. The Farm Water Supply. By Fred W. Morse.

No. 54. The Winter Food of the Chickadee. By Clarence M. Weed.

No. 55. The Feeding Habits of the Chipping Sparrow. By Clarence M. Weed.

No. 56. Poisonous Properties of Wild Cherry Leaves. By Fred W. Morse and Charles D. Howard.

No. 57. Forage and Root Crops. By F. Wm. Rane.

No. 58. Cost of Raising Calves. By Fred W. Morse.

Digitized by Google

No. 59. Tenth Annual Report.

The reports of the different members of the Station Council are given in the succeeding pages.

During the year the Department of Chemistry has been assisted a portion of the time by Messrs. Charles W. Vickery, B. S., Arthur Given, B. S., and Harry E. Barnard, class of '99, N. H. C. It is the policy of this department to respond as promptly as possible to the applications from the public for analyses of fertilizers, and other substances pertaining to agriculture. This class of work and the fertilizer inspection for the State Board of Agriculture have required about one half of the department's time. Its scientific investigations have, therefore, been continued from year to year in order to obtain results that will justify a bulletin. Besides a report on fertilizer analyses, the department has issued a bulletin on the farm water supply, including observations made during several years, and one on the poisonous properties of wild cherry leaves, covering the work of two successive summers.

Respectfully submitted.

FRED W. MORSE,
Vice-Director and Chemist.

PUBLICATIONS OF THE EXPERIMENT STATION.

During the ten years since its organization the New Hampshire College Agricultural Experiment Station has issued fifty-nine bulletins in regular series, six annual reports, and two special bulletins. Press bulletins have also been prepared for the use of the newspapers; but they are simply abstracts of the regular bulletins, and are not for general distribution, since they contain no new matter.

The list of regular bulletins is as follows:

No. 1. Ensilage.
No. 2. Feeding Experiments.
No. 3. When to Cut Corn for Ensilage.
No. 4. The Science and Practice of Stock-Feeding.
No. 5. Fertilizers and Fertilizing Materials.

Digitized by Google

No. 6. Experiments with Fertilizers.

No. 7. Test of Dairy Apparatus.

No. 8. Feeding Experiments. Part 1. Principles of Feeding. Part 2. Corn Meal, Middlings, Shorts, and Cotton-Seed compared.

No. 9. Effect of Food upon Milk.

No. 10. Co-operative Fertilizer Experiments.

No. 11. Pig Feeding. Part 1. Results of Feeding Skim Milk and Corn Meal versus Corn Meal and Middlings. Part 2. Digestion Experiment.

No. 12. Fertilizer Experiments.

No. 13. Part 1. Effect of Food on Butter. Part 2. Effect of Food on Quantity of Milk. (Out of print.)

No. 14. Ensilage in Dairy Farming.

No. 15. Patent Cattle Foods.

No. 16. Effect of Food on Composition of Butter Fat.

No. 17. Stock Feeders' Guide.

No. 18. Effect of Food on Milk.

No. 19. Spraying Apples and Pears against Fungi.

No. 20. Effect of Food on Milk. Feeding with Fats.

No. 21. Farm-yard Manures and Artificial Fertilizers.

No. 22. Prevention of Potato Blight.

No. 23. Some Dangerous Fruit Insects.

No. 24. The Flow of Maple Sap.

No. 25. The Composition of Maple Sap.

No. 26. Analyses of Fertilizers and Wood-Ashes.

No. 27. Spraying Experiments in 1894.

No. 28. Remedies for the Horn Fly.

No. 29. Remedies for Flea Beetles.

No. 30. An Experiment in Road Making.

No. 31. Seventh Annual Report. 1895.

No. 32. Studies of Maple Sap.

No. 33. Two Shade-Tree Pests.

No. 34. Surface and Sub-Irrigation out of Doors.

No. 35. The Codling Moth and the Apple Maggot.

No. 36. Analyses of Three Common Insecticides.

No. 37. Crimson Clover.

Digitized by Google

No. 38. The Tent Caterpillar.
No. 39. The Army Worm.
No. 40. Eighth Annual Report. 1896.
No. 41. Potatoes: Varieties, Fertilizers, Scab.
No. 42. Part 1. Tomato Growing in New Hampshire. Part 2. Notes on Tomato Breeding.
No. 43. Some Inferior Wood Ashes. Adulterated Paris Green.
No. 44. The Canker Worm.
No. 45. Fruit and Potato Diseases.
No. 46. Part 1. An Experiment with a Steam Drill. Part 2. Methods of Road Maintenance.
No. 47. Strawberries in New Hampshire. (Out of print.)
No. 48. Ninth Annual Report. 1897.
No. 49. The Inspection of Fertilizers in 1897.
No. 50. Dehorning Cattle.
No. 51. Sweet Corn for New Hampshire.
No. 52. Growing Muskmelons in the North.
No. 53. The Farm Water Supply.
No. 54. The Winter Food of the Chickadee.
No. 55. The Feeding Habits of the Chipping Sparrow.
No. 56. Poisonous Properties of Wild Cherry Leaves.
No. 57. Forage and Root Crops.
No. 58. Cost of Raising Calves.
No. 59. Tenth Annual Report. 1898.

It will be noticed that, beginning with 1895, the annual reports of the station have been issued as bulletins in the regular series. Previous to 1895, the annual reports were issued as Part II of the report of the college, and were numbered as follows:

First Annual Report. 1889.
Second Annual Report. 1890.
Third and Fourth Annual Reports. 1892.
Fifth Annual Report. 1893.
Sixth Annual Report. 1894.

The Third and Fourth Annual Reports are now out of print, but, aside from the financial statements, they contain no

Digitized by Google

matter outside the regular bulletins, since they include only the bulletins issued during those years.

The two special bulletins issued were intended for local distribution, and contained merely an explanation of the weather signals displayed at the station.

DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

The department remained the same as last year until September 15, when it was divided, and Mr. C. W. Burkett was promoted to take charge of the department of agriculture. This report as regards agriculture, therefore, ends upon September 15, last, while that of horticulture is given up to the present time.

The work during the past year has been mainly along agricultural lines. The results with various fodder crops, which have been grown the past three seasons, has been already published in Bulletin 57, and the reader is referred to it for these crops. A general study of rotations for the college farm has been outlined, and although it does not come directly under the head of experimental work, it is to a great degree of that nature. During the latter part of the year, the time of the head of the department has been taken up mainly in getting the agricultural work in shape, either for publication or to turn over to the new agriculturist. A few further experiments follow:

Destroying the Oxeye Daisy.

The oxeye daisy easily disseminates itself wherever farming is neglected. It can be kept from farms, however, if precaution is exercised. We have seen several farms in New Hampshire that are completely surrounded with this weed, but are kept absolutely free from it.

During the past few years the writer has had considerable experience in endeavoring to overcome this pest, in the course of which the following experiment was made. One method

Digitized by Google

of keeping it from spreading commonly practised is to cut the hay early, and thus avoid the maturing of the seeds. In order to ascertain just how elastic this period might be, in July, 1897, a number of daisy blossoms were collected for study. The date of the opening of each blossom was noted, and specimens were taken at various periods from this time on.

The following tables show the results: Table I gives the date when the blossoms first opened and when they were collected, thus showing the number of days open. It also gives the number of seed tested for each period, and the number that germinated, thus showing the percentage of germination.

TABLE I.

No.	Opened.	Collected.	Days in bloom.	No. seed tested.	No. germinated.	Per ct. germ.
1	July 8	July 10	2 days.	730	.....	.....
2	" 8	" 13	5 "	730	.....	.....
3	" 8	" 14	6 "	780	.....	.....
4	" 8	" 16	8 "	930	.....	.....
5	" 20	" 29	9 "	930	.....	.....
6	" 20	" 30	10 "	380	.....	.....
7	" 8	" 20	12 "	1,030	7	.007
8	" 8	" 23	15 "	1,180	23	.020
9	" 8	" 28	20 "	930	28	.030
10	Dead ripe.		Unknown.	1,230	324	.260

Table II shows only the results of those which germinated, and the date and number of seed used at each test. These observations would lead us to believe that it takes at least twelve days for seed maturity of the daisy after it first blossoms.

Digitized by Google

TABLE II.

SEED TESTED.	No. 10.		No. 9.		No. 8.		No. 7.	
DATE.	Seed in test.	Germinated.	Seed in test.	Germinated.	Seed in test.	Germinated.	Seed in test.	Germinated.
October 18....	50	8	50	3	50	.....	50	.....
November 1....	20	2	20	.....	20	.....	20	.....
December 6....	60	.....	60	.....	60	.....	60	.....
February 4	100	20	100	.....	100	1	100	2
March 10....	200	8	200	2	200	1	200	.....
April 15....	800	286	500	23	750	21	600	5
Total	1,230	324	930	28	1,180	23	1,030	7

Figure 1 is a photograph of a field adjoining the college farm, and represents the first growth from newly seeded ground. After the daisy matured there was such a good growth of timothy that the presence of the daisy could not be detected except upon close examination.

LIMING.

A number of experiments have been carried on to test the value of lime when applied to our soil.

Experiment 1. On July 9, 1896, we completed the preliminary work upon an old meadow. The field had been in grass for an indefinite number of years, and was practically exhausted. It was plowed up and staked off into plots, all of which were prepared alike. The plant food used was commercial fertilizer. Three series of plots of two each were used in the experiment, one in each being limed at the rate of one ton per acre, while the other was used as a check. The soil is a clay loam, rather low and not very well drained,—fairly representative of the grass lands in this section of the state. The following data show the results for the past two seasons, in each case on one acre of land.

Digitized by Google

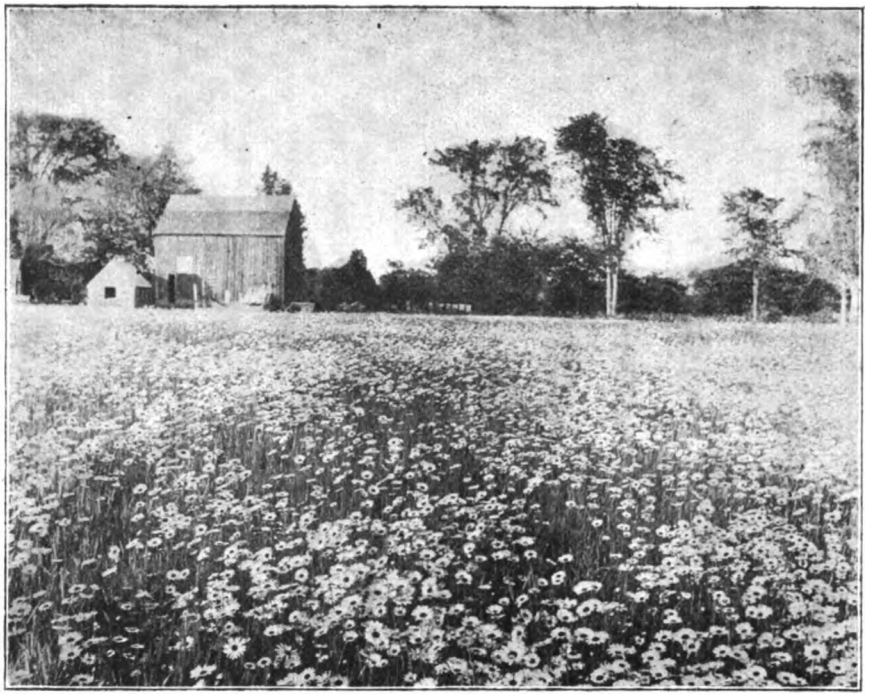


Fig. 1.— Daisies in newly seeded grass field. (Not on the College farm.)

Digitized by Google

Plot.	Kainit.	Acid phosphate.	Lime.	Yield per acre. 1897.	Yield per acre. 1898.	Two-year average.
1	800 lbs.	600 lbs.	.....	3,480 lbs.	1,600 lbs.	2,540 lbs.
2	800 "	600 "	2,000 lbs	4,520 "	1,760 "	3,140 "
	Balance favor of lime			1,040 lbs.	160 lbs.	600 lbs.

Plot.	Muriate potash.	Acid phosphate.	Lime.	Yield per acre. 1897.	Yield per acre. 1898.	Two-year average.
3	200 lbs.	600 lbs.	.....	3,360 lbs.	1,440 lbs.	2,400 lbs.
4	200 "	600 "	2,000 lbs.	4,440 "	2,080 "	3,260 "
	Balance favor lime			1,080 lbs.	640 lbs.	860 lbs.

Plot.	Muriate pot. ash.	Acid phosphate.	Nitrate soda.	Lime.	Yield per acre. 1897.	Yield per acre. 1898.	Two-year average.
5	200 lbs.	600 lbs.	120 lbs.	.....	3,800 lbs.	2,520 lbs.	3,160 lbs.
6	200 "	600 "	120 "	2,000 lbs.	4,280 "	2,520 "	3,400 "
	Balance favor of lime				480 lbs.	.....	240 lbs.

From these results it is evident that the lime has been more effective in the first season's growth.

Experiment 2. This was an experiment with *versus* without lime, and was begun on potato land in the spring of 1896. As the season was unfavorable, and the tubers rotted badly, no notes were taken. The ground, which was a lightish loam, was plowed for the first time in a number of years. The following year the land was planted to the Leaming variety of ensilage corn, with the following results:

Ensilage corn with lime,	16,820 lbs. per acre.
Ensilage corn unlimed,	12,180 lbs. per acre.
Difference in favor of limed,	4,640 lbs. per acre.

Digitized by Google

This yield is low for either plot, but the facts that the land had been so shortly reclaimed, and that commercial fertilizers were depended upon entirely, no humus being added, account for it.

During the last cultivation of the corn, the land was seeded to clover and grass, to carry the experiment still another season. The weight of grass taken from these plots this season was, for the limed, 2,975 pounds, and for the unlimed, 2,660 pounds,—a difference of 315 pounds in favor of the limed land. The second crop was pastured, and therefore is not included in the above weights.

Experiment 3. This experiment was undertaken last spring through the assistance of two students in the Two Years' Course in Agriculture, Mr. C. W. Martin and Mr. G. H. Wheeler, to ascertain if the various fields of the college farm would be helped by liming. The work carried out in the main was to apply the tests recommended by Professor Wheeler of Rhode Island,* "How to Ascertain if a Soil will be Helped by Liming." The method, which is simple and should be understood by every one, is as follows:

"A tablespoonful or more of soil is placed in a tumbler or cup and moistened with sufficient water to make the mass of about the consistency of a thick paste. It is best to allow it to stand for from fifteen to twenty minutes before making the test, though it may be made at once. With a knife blade part the soil and introduce one end of a slip of *blue litmus paper,*† which may conveniently be one half to three quarters of an inch wide and two inches long, press the soil about the paper, and after from two to five minutes remove the paper without tearing it, rinse off the adhering soil with water and note whether it still retains a blue tint or has become positively red. If the paper has been strongly reddened, it may be concluded that lime will probably benefit many crops which may be grown upon the soil. If the soil has a marked reddish tint, as is sometimes the case, it may be better to bring

* Bulletin 46, R. I. Agricultural Experiment Station.

† A few cents will buy enough at any apothecary store to make many tests.

Digitized by Google

but one side of the paper in contact with it, and if a red color comes through to the other side it may be concluded that the soil is acid. In all cases care must be taken not to handle the end of the paper which is used for making the test, since the touch of the fingers may redden it and thus one might be deceived.

"In case a soil contains any considerable excess of carbonate of lime and magnesia, the humus is mostly combined with lime and magnesia, and in such a case if a teaspoonful of soil is stirred into a glass of water to which a few drops of *ammonia water** have been added, and the whole set aside for some hours, the liquid which remains at the top will be nearly colorless, but where lime and magnesia are lacking in a soil the liquid has usually a dark brown or black appearance, the intensity of color depending upon the amount of soil taken, and of course upon its need of lime."

The above instructions were carried out upon a number of fields by each student. In some cases where the ground is rolling and conditions vary, samples were taken, as, for example, from the high, medium, and low ground. Both tests were made, but upon compiling the notes, it was found that both the *litmus* and *ammonia water* tests practically showed the same results. Consequently, but one table is necessary.

Field.	Elevation of ground.		
	Low.	Medium.	High.
McDaniel	Decidedly acid	Acid	Neutral.
Creamery	Decidedly acid		
North	Decidedly acid		Acid.
Heater	Decidedly acid		Slightly acid.
Experiment	Slightly acid	Acid	
East of athletic ground	Decidedly acid		
Thompson	Decidedly acid		
Black swamp			Slightly acid.
Black swamp—corn	Very slightly acid		Slightly acid.
+ Lime, 1,500 lbs.—potatoes.	Very slightly acid		

* This is to be had of any apothecary for a few cents.

Digitized by Google

SEEDING GRASS LANDS WITH *vs.* WITHOUT A NURSE CROP.

That grass lands can be seeded, when known to be perfectly free from weed seeds, without a nurse or protective crop, and with the best of results, there is no question. We quote from experiments carried on by Henry at the Wisconsin Experiment Station, in order to impress the importance of thorough cultivation as well as to show under what conditions success is assured.

* "1. The land must be quite free from weed seeds. If there are many weed seeds in the ground, these can be destroyed by summer-fallowing or by 'freshing' the ground several times before the grass seeds are sown. It positively will not do to sow grass where the ground is foul with weed seeds.

"2. The land should possess at least fair fertility in order to produce early springing and rapid growth of the young grass plants from the very beginning.

"3. The land must be very carefully prepared. In this there is nothing but gain to the husbandman by doing his work well. Every inch of the soil should be gone over again and again, and the surface rendered as smooth as a table and as fine as an onion bed. We have been very careless in the past in regard to the proper treatment of grass lands, and must improve in the future if we desire the heavy crops possible.

"4. It is well to sow large quantities of grass seed—two or three times the usual amount. In seeding, the field should be crossed both ways, if possible, so as to insure entire absence of skips or breaks in the evenness of the young sward.

"5. It is probably best, although we have not fully demonstrated the fact, to sow grass and clover seed very early in the spring time. Our returns for the present year, and those of some of our student correspondents, show the beneficial effects of very early seeding.

"6. Finally, a matter of much importance is that of checking the growth of weeds, which will annoy more or less in spite of all precautions. There being no grain crop to check

* Thirteenth Annual Report Wis. Agricultural Experiment Station. 1896.

Digitized by Google

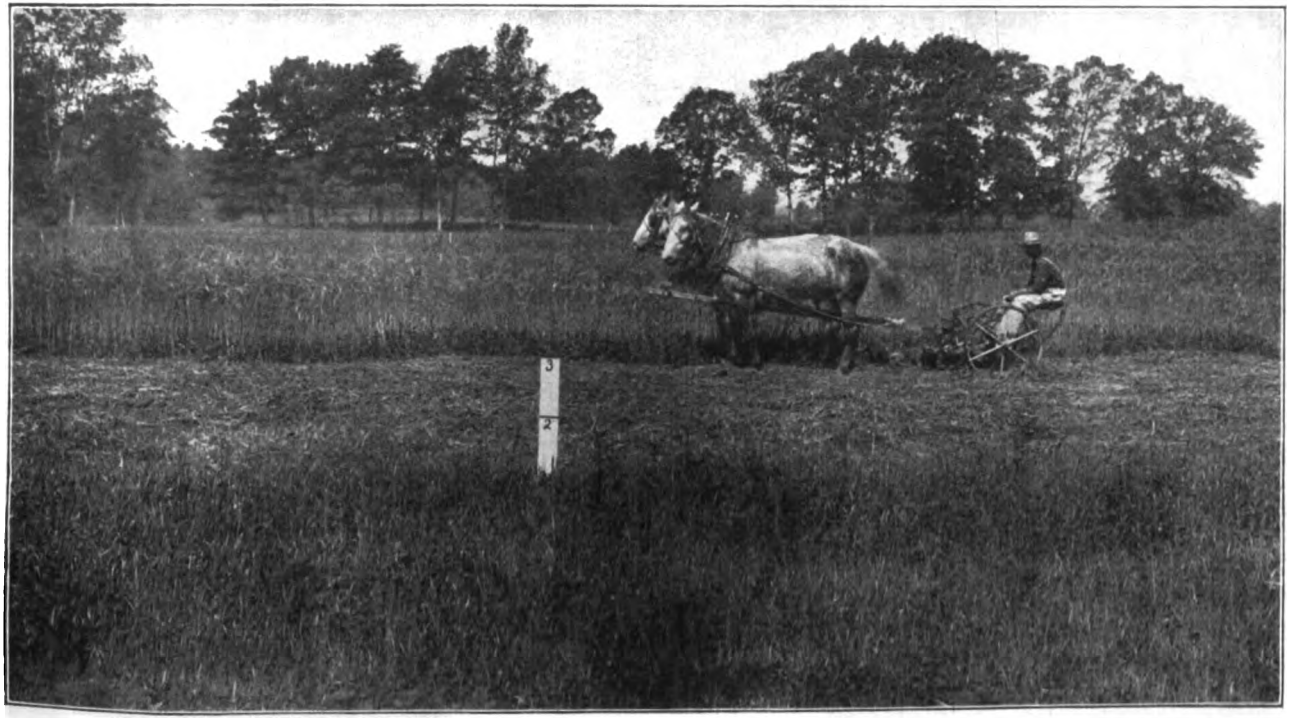


Fig. 2.—Seeding with *vs.* without a nurse crop. This side the measuring stake represents a strip seeded without, while that beyond is seeded with barley. First crop July 16th, 1897.

Digitized by Google

this growth, weeds luxuriate amazingly in the young seeding of grasses and clovers. When the weeds reach a height of six inches, the mower should be put into the field with the cutter bar set about four inches high. It is very light, rapid work trimming off the weeds, and the field is then most attractive in its even carpet of green. The young grass and clover plants are hurt far less by this mowing than are the weeds, and, their leaves shooting up, overtop the weeds, and hiding them from the sun choke them down. Sometimes, the mowing of the weeds must be repeated."

From the above it is readily seen that the average grass lands of New Hampshire, in order to produce a crop of grass and clover without a protective crop, must be judiciously handled.

An experiment was undertaken in the spring of 1897 on land that had been thoroughly cultivated with ensilage corn the two preceding years, and therefore was fairly clean. The ground was plowed and dressed with a fair coating of barnyard manure, supposed to be above the average as regards purity from weed seeds. It was worked in with a cutaway harrow. The soil was a heavy clay, but fairly well-drained, somewhat rolling; typical of the grass lands of this section. The following mixture of grass seed was used per acre: 5 pounds of alsike clover, 7 pounds choice red clover, 5 pounds of red-top and 12 of timothy or herd's-grass. A large plot of this, extending across the field, was staked off, and the remainder sown to barley, as a nurse crop, at the rate of three pecks per acre.

The season was favorable for grass, and on July 16, the barley was cut and cured for fodder. Figure 2 is a half-tone from a photograph taken on the above date, and shows the comparative heights of the two seedings. The measuring stake in the center of the photograph stands upon the dividing line of the two plots. The grass in the barley, as can be seen in the cut, had made an excellent growth, being a foot high and very heavy. The grass grown without the barley, as shown in the fore part of the photograph, was much

Digitized by Google

smaller, and although the weeds were cut back once, was by no means so far advanced. The ragweed seemed to be the most troublesome in patches. The yield of barley and young grass in the first cutting was at the rate of 2 tons 372 pounds per acre when cured. The second crop from this same ground, which was clover, was cut during September, and put directly into the silo. This weighed in the green state at the rate of 3 tons, 1475 pounds per acre, or allowing fifteen per cent discount for curing, 3 tons, 353 pounds.

The plot without barley was cut on August 13, and yielded at the rate of 1 ton, 680 pounds of hay per acre. The true grasses were more in evidence in this plot, although there was a good catch of clover. The grass on the plot was not cut for a second crop.

During the present season it was found that the plot without the barley was the first to advance. It made a very rank growth. On June 1, the grass lodged badly, and was much heavier than the remainder of the field. It was cut on June 23, and the rate of yield for each per acre was as follows: For land stocked with barley, 2 tons, 1219 pounds, and for that without barley 4 tons, 1600 pounds. The second crop was pastured and no weights taken.

This experiment shows that although the crop with barley exceeded that without the first season, it came nearer being equal when extended over two years. Comparing the total weights for the two seasons the excess in favor of that with barley is 1 ton, 1662 pounds. I have no data to show whether if the experiment were continued longer, the plot without the nurse crop would fully equal the other or not.

An experiment was made by cutting a large strip across a newly seeded piece when the barley was but two thirds grown. This accomplished practically nothing, however, as the second crop of grass on this strip could not be distinguished from the rest of the field. The barley thus cut was used for soiling.

Last spring a number of plots were prepared for sowing various leguminous plants without a nurse crop. It so hap-

Digitized by Google

pened that the ground previously contained witch grass, which entirely choked out the various varieties of clover.

Conclusions:

1. Where it is positively known that the land is fertile and free from weed seeds, also that the fertilizer used is not contaminated, grass can be grown with success without a nurse crop.

2. Where barn-yard manures are used, or where the soil is not thoroughly cleansed of weeds, the nurse crop is an advantage in that it checks the weedy growth; also, if cut early for hay, as is common in New Hampshire, the grass has more time to develop, usually resulting in a good second crop.

3. It is but little more work to cut the nurse crop than under ordinary conditions it would be to cut the weeds. In the former case the green crop would compensate for the work.

4. The nurse crop takes nourishment from the soil that might otherwise go to the grass, but nothing is lost, as its value is realized from the crop itself.

5. Should the largest returns be expected the first season, or in case of a rotation in the earlier years of the rotation, it is better to use the nurse crop, unless the conditions are ideal for sowing grass seed by itself.

6. When witch grass is present it is practically impossible to get a fair catch of clover without a nurse crop.

7. From these experiments, taking everything into consideration, we believe that for our general New Hampshire conditions it is advisable to use the nurse or protective crop.

Top-Dressing Grass Lands.

In the spring of 1897 an experiment was carried on in top-dressing a field that apparently was about run out. The yield of hay would but pay for the labor. Two one-acre plots were selected, and one was dressed in the spring with the following mixture of fertilizers,—100 pounds of nitrate of soda, 100 pounds of dissolved bone black, and 50 pounds of muriate of potash. The other was utilized as a check.

Digitized by Google

The season was wet and very favorable for the grass crop. The yield from the fertilized plot was 3,840 pounds, and from the check plot, 2,930, making a difference in favor of the former of 910 pounds. These same plots were cut the present season without further treatment, giving 2,420 pounds from the fertilized plot, and 1,600 pounds from the other,—820 pounds in favor of the fertilized.

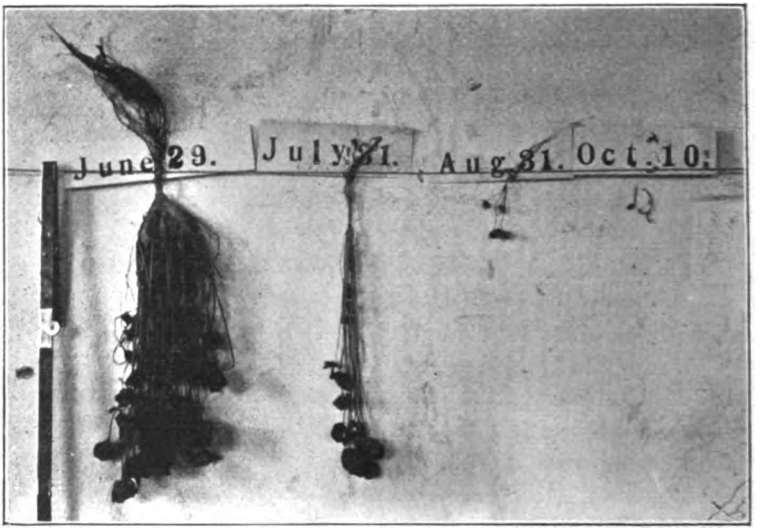


Fig. 3.—Crimson clover sown at different times throughout the season.

Sowing Crimson Clover in Different Months.

An experiment has been conducted for studying the result upon this crop when planted at different times during the growing season. Sowings were made June 29, July 31, August 31, October 10, and November 6. In the late fall a representative specimen of each of the seedlings was photographed, as shown in Figure 3. From these it is seen that the plants attain a fair size when planted early. All were unable to withstand the winter climate. An occasional plant in each of the earlier sowings came through and blossomed.

Digitized by Google

As was shown in Bulletin No. 37 of this station, this is more proof that crimson clover does not withstand our winter climate. Its main value is in its growth of the first season, and it must therefore be considered as an annual with us. As a crop for seeding in fruit plantations, simply for the additional food value of the plantation and to keep the soil from washing during winter, it is valuable; but even here the seeding should be done early in August in order to obtain desirable results. Comparing crimson clover with the medium red variety, there seems to be little if any gain in its use. If the medium red and alsike are mixed, our experience shows that because of their ability to withstand the winters, while in all other respects they answer the same purpose, they are equally valuable if not more so.

Thomas Slag *vs.* Redondite as a Fertilizer.

A comparative test of these two phosphoric acid fertilizers was undertaken in the late spring of 1897, upon land seeded to grass. The nitrogenous and potash fertilizers were applied in equal quantities on both plots, and consisted of 80 pounds of nitrate of soda and 400 pounds of kainit per acre. The Thomas slag was used at the rate of 160 pounds per acre on plot 1. Plot 2 was equally divided. Raw redondite was used on one half at the rate of 80 pounds per acre, and roasted redondite at the rate of 40 pounds per acre on the other.

The barley used as a nurse crop was cut on September 7 with the following yields: Thomas slag plot, at the rate of 1,312 pounds, raw redondite, 1,520 pounds, and roasted redondite, 1,424 pounds per acre. The present season these same plots were weighed at haying time, with the following results: Thomas slag, 3,704 pounds, raw redondite, 4,320 pounds, and roasted redondite, 3,248 pounds per acre.

In each year, as is shown in the data, the raw redondite gave the greatest yield. Of the other two, the roasted redondite exceeded the Thomas slag by 112 pounds per acre in the first year, while in the present season it was reversed, the Thomas slag yielding 456 pounds per acre more than the

Digitized by Google

other. From this experiment, therefore, their values are in the following order,—raw redondite, first; Thomas slag, second, and roasted redondite, third.

Fruit Calendar for 1898.

On the whole this has been a fruit year. Doubtless other seasons have given larger yields of special kinds, as, for example, the over-abundant apple crop of 1896, the pear crop of last season, etc. However, taking into consideration fruits of all kinds from the apple to the smallest bush fruits, the season has been an ideal one in many respects.

The apple crop has varied in different sections, but in general has been productive. The fruit on the average is large, well-colored, and comparatively free from blemishes. Where 200 barrels were expected from the college farm, the yield was much nearer 300 barrels. The fall and summer fruit was very fine and productive, and brought good prices. It is a mistake not to market the fall apples, even though only a few trees are grown; if the fruit is well graded and nicely packed, it brings paying prices. Even the poorest apples, well sorted, netted us $1.50 per barrel this season.

When traveling in the northern part of the state the writer was completely surprised to find to what an extent the apple is grown. From Colebrook, Mr. Jordan has been shipping fall apples to Minneapolis and other places in the Northwest by the car-load, netting $1.75 per barrel. About Lancaster apples are doing well; at the State Grange fair at Tilton, J. D. Howe and Son of this place made a very fine display. All of the fruit in this northern section is highly colored and beautiful. Mr. Howe finds a home market for all he can raise. Another Lancaster man, Mr. B. C. Morse, agrees with Mr. Howe that they now have a winter apple that is destined to revolutionize the apple industry in this section. The variety is the Bethel. Its principal recommendations are its hardiness, flavor, and good keeping qualities. A description and figure of this fruit will be given in some future report.

This section is too far north for the Baldwin, which matures only under sheltered conditions. Mr. Howe sends me

Digitized by Google

the following list of varieties, all of which, he says, do well with him. They are named in order of their ripening: Yellow Transparent, Tetofskey, White Astrachan, Red Astrachan, Peach, Duchess of Oldenburg, St. Lawrence, Alexander, Fall Jenetting, Fameuse, Wealthy, Nodhead, Porter, Tolman Sweet, Bethel, McIntosh Red, Twenty Ounce, Yellow Bellflower, Northern Spy, Stark, and Ben Davis.

Pears likewise do well in the northern section of the state, the following four varieties having been recommended: Flemish Beauty, Clapp's Favorite, Louise Bonne de Jersey, and Vermont Beauty; the last Mr. Morse claims is very fine.

Of plums Mr. Howe says the Bradshaw, Canada Egg, and Lombard are as good as any, but Moore's Arctic, Saratoga, Bonne Lee Anne, Green Gage, Chautauqua, Saunders, Abundance, and Damson all do well.

Mr. Morse reports that the three varieties of cherries, namely, the Ostheim, Early Richmond, and Nindswerth, are all valuable.

At the Bethlehem fair, the writer saw evidences of no little horticultural progress. The fruit displayed was very fine, and the outlook for this section, situated as it is in the White Mountains, is thought to be very bright. Those experienced say that no one has yet demonstrated the possibilities with fruits here. Small fruits are being raised more and more. One man, Mr. E. E. Bishop of Bethlehem, raised four acres of strawberries the past season. Formerly this fruit came chiefly from Boston gardeners.

In the central and southern parts of the state there was a very fair crop of peaches. Mr. George Tuttle of Barrington had a crop of over 1,000 baskets, all of which were very fine. The orchard of Mr. Stratton in Hollis, which he reported last year, gave a crop this year almost as fine as that of last season. The main varieties used by both of these men are Mountain Rose and Early Crawford. Mr. Tuttle raises some Fosters and Wheatlands which he values highly. The peach rot has been very troublesome during the past season. Strawberries have been over-abundant in some markets this year. Red raspberries seemed to be scarce and brought good prices.

Digitized by Google

The main lines in horticultural work at the station during the year have been with potatoes, muskmelons, and strawberries. Much work of an experimental nature has been done in the greenhouses, all of which will be published in bulletin form.

F. WM. RANE,
Horticulturist.

DEPARTMENT OF AGRICULTURE.

THE COLLEGE HERD.

The college dairy herd at present is composed of sixteen Jerseys, six pure bred and ten grades; seven Ayrshires; five Guernseys; three grade Durhams; and two grade Holsteins.

HERD RECORD FROM NOVEMBER 1, 1897, TO OCTOBER 30, 1898

MONTH.	Milch cows.	Dry cows.	Pounds of milk.	Average for each milch cow.	Average for herd.	Average fat test.	Pounds of butter.
November	27	9	13,854	513	385	4.7	756.73
December.....	28	8	15,812	564	439	4.6	841.43
January.....	25	9	15,167	606	446	4.6	800.90
February	26	7	13,780	530	417	4.6	745.76
March	25	8	15,014	577	455	4.5	897.32
April	23	10	13,536	588	410	4.57	710.18
May	26	7	15,862	610	480	4.4	800.33
June	26	7	16,414	631	497	4.4	871.78
July	28	5	16,322	563	494	4.6	875.94
August	27	6	12,609	467	382	4.75	698 47
September	25	8	12,713	508	385	4.6	682.25
October	23	10	11,928	562	362	5.0	695.80

The herd has been equivalent to 309 milch cows and 94 dry cows for one month and has produced 173,011 pounds of milk and 9,376.89 pounds of butter, making an average monthly yield per head for 403 cows, 429 pounds of milk and 23.3 pounds of butter, or 5,148 pounds of milk and 280

Digitized by Google

pounds of butter for the year. The data have been taken from the daily and weekly records of the barn and creamery, and the butter calculated by the standard formula, butter= $1+\frac{1}{6}$ fat instead of the actual weights obtained, since the latter would involve corrections for cream and milk sold.

The work of this department during the past year was connected with that of the department of horticulture, and the record of the work is given in the report of the horticulturist.

CHARLES W. BURKETT,
Agriculturist.

DEPARTMENT OF BACTERIOLOGY.

The work of this department during the past year has been chiefly a continuation of various lines of investigation previously begun, viz., dairy bacteriology; the study of the root tubercles of the leguminous plants, both wild and cultivated; study of the life history and treatment of black knot of plum and cherry, and the fungous diseases of the apple. Experiments in the measurement of temperatures by electrical means, and in the bacteriology of ensilage have been begun.

EDIBLE MUSHROOMS.

For some time in different quarters there have been signs of an awakening interest in the study of mushrooms, especially with a view to their use as food. The writer has for several years been interested in their study from a botanical point of view, and it seems to him worth while to call the attention of those whom this report is likely to reach to some of the facts in regard to them.

Mushrooms are not only palatable but many are to be considered as delicacies. Mushrooms are nutritious, being comparable in this respect to the meats. Mushrooms at certain seasons are very abundant. In spite of these facts comparatively few people in this country make use of the wild species for food. This is undoubtedly due to the fact that it is known that some varieties are exceedingly poisonous. Therefore, those who do not know anything about the different

Digitized by Google

kinds do well to let them all alone. There is, however, no good reason why persons who will take a little pains to become acquainted with these plants should not be able to avoid the dangerous ones and to enjoy the edible ones. It is the object of this paper to call attention to the poisonous ones, rather than to point out the harmless ones. For the former are com-

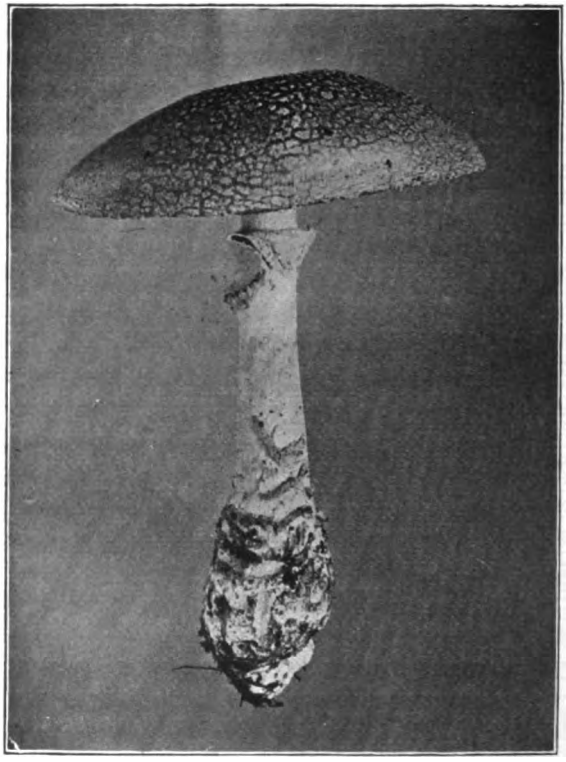


Fig. 4.—Fly Agaric. Poisonous.

paratively few, and being once known so as to be avoided a great part of the danger of mushroom eating is removed.

According to popular belief, mushrooms are edible and toadstools are poisonous; the botanist calls them all mush-

Digitized by Google

rooms, but recognizes the fact that some are poisonous and others are not, just as is the case with higher plants. Mushrooms belong to that great class of plants known as fungi, which differ from ordinary plants in their shape, color, and mode of life. They consist of a vegetative part and a reproductive part. The vegetative part is usually inconspicuous and simple in structure, consisting of a mold-like mass of minute colorless threads known as the mycelium, which grows on decomposing vegetable matter on the surface of the soil or on dead trees. The reproductive part is by far the largest and most conspicuous part, and is what is commonly called the mushroom. It assumes various forms, the most common of which is the familiar umbrella shaped structure consisting of a *stem*, and an expanded portion called the *pileus* or *cap*. The under side of the cap is covered either with thin radiating plates called *gills*, or with minute closely packed tubes or *pores*. On the surfaces of the gills or in the cavity of the pores the reproductive bodies or *spores* are borne. In some species in the young state the gills or pores are covered by a membrane known as the *veil*. As the mushroom develops this becomes detached from the circumference of the cap and may either fall off or remain attached to the stalk, when it is known as the *ring*. In some species, when very young, the whole mushroom is inclosed in a membrane called the *volva*; this is soon torn apart but traces of it may remain even in the mature state as wart-like projections on the cap or as a cup-like structure on the base of the stem, out of which the stem grows as from a socket. This cup is a mark of the highest importance in distinguishing the dangerous varieties. Poisonous mushrooms may be divided into two classes: those which are deadly and those which only produce nausea or some other digestive disturbance, but are not usually fatal. It is believed by authorities that all of the deadly varieties show the cup in some form at the base of the stem. If, therefore, one becomes familiar with its appearance, and is able to detect it, he will be able to avoid the chief dangers of poisoning.

At least two of the deadly varieties are common in New

Digitized by Google

Hampshire. They both usually grow either in the woods or at the border of woods or thickets. One is almost pure white, with a smooth cap, or possibly warty when young, and certainly presents a most innocent appearance; but at the base

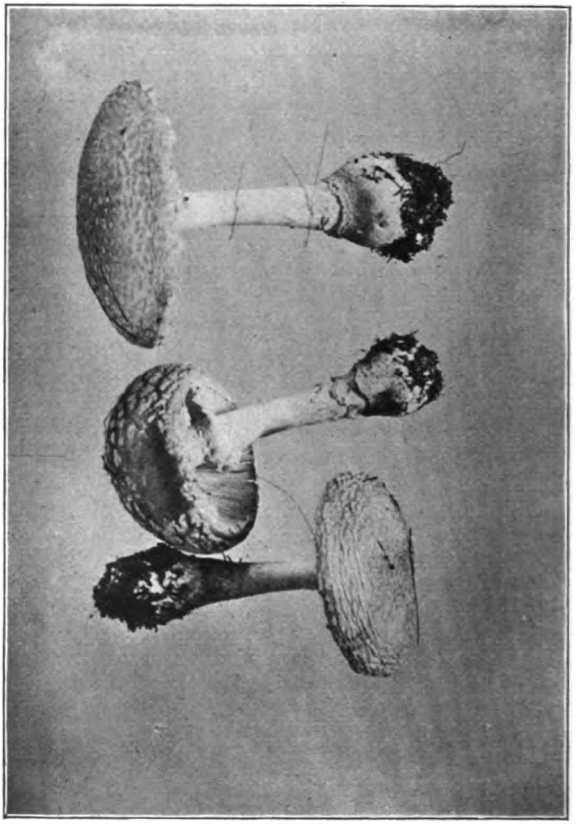


Fig. 5.—Fly Agaric. Poisonous.

of the stem, usually concealed in the decaying vegetable matter in which it grows, is to be found the well marked cup which is the sign of warning which must not be disregarded; it is deadly poison. Here is to be noted a precaution which should never be neglected in collecting mushrooms for eating purposes: *Never break off* the mushroom, but, so to speak, dig

Digitized by Google

it up by the root; for only by so doing can one be certain that there is not a warning cup at the bottom of the stem.

One of the largest, handsomest, and in the latter part of the summer and fall, one of the commonest mushrooms is the *Agaricus muscarius* or "fly agaric," so called from its sometime use as a fly poison. It varies greatly in size and color; the stem is from three to seven inches in length; the cap has about the same range of diameter. The upper surface of the cap varies in color from almost white through yellow to orange or scarlet; it is studded more or less thickly with warty scales of a light color, the remnants of the volva. The gills are white, as is also the stem. The cup is present, but usually it is not so distinct as in the above-mentioned species. The lower part of the stem is more or less swollen or bulbous, the upper part of the bulbous portion being covered by a ragged surface sometimes showing a well marked ring corresponding to the margin of the cup, sometimes showing several rings, perhaps incomplete, one above the other. This mushroom is also deadly poison. Figures 4 and 5 show specimens. Figure 6 shows three young specimens which have but just broken out of the volva, the remains of which are seen on the unexpanded cap and on the bulbous base of the stem.

All mushrooms with a cup or the suspicion of a cup should be rejected.

None of the others are considered dangerous to life, although they may produce unpleasant symptoms. The possession of harmful properties is usually accompanied by a bitter, acrid, peppery, or otherwise unpleasant taste; all such should be rejected. If the mushroom is without a cup it should be tasted; if it is tender and pleasant to the taste the probability is that it is not poisonous. Mushrooms should be gathered and eaten when fresh, as they soon become infested with insects and begin to decay.

In testing the edible properties of an unfamiliar species it is well to begin with a small portion, gradually increasing the amount if no unpleasant symptoms follow the first trials.

Digitized by Google

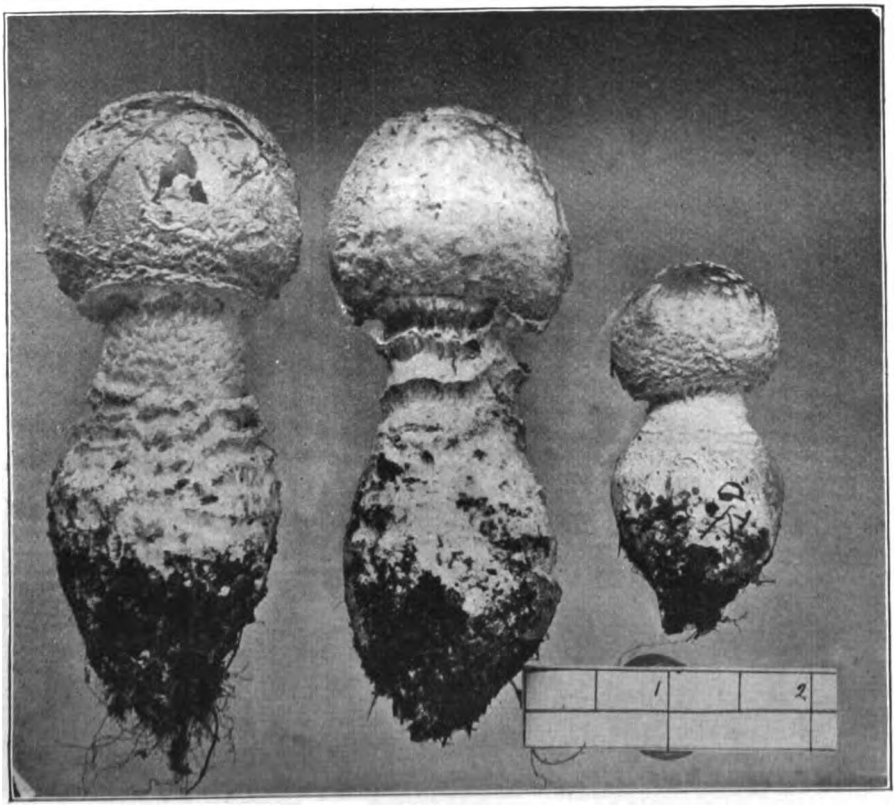


Fig. 6.—Fly Agaric, young. Poisonous.

Digitized by Google

Dr. W. G. Farlow, in Bulletin 15, United States Department of Agriculture, gives the following rules:

"1. Avoid fungi in the button or unexpanded stage; also, those in which the flesh has begun to decay, even if only slightly. 2. Avoid all fungi which have stalks with a swollen base surrounded by a sac-like or scaly envelop, especially if the gills are white. 3. Avoid fungi having a milky juice, unless the milk is reddish. 4. Avoid fungi in which the cap or pileus is thin in proportion to the gills, and in which the gills are nearly all of equal length, especially if the pileus is bright colored. 5. Avoid all tube-bearing fungi in which the flesh changes color when cut or broken, or where the mouths of the tubes are reddish, and in the case of other tube-bearing fungi experiment with caution. 6. Fungi which have a sort of spider-web or flocculent ring around the upper part of the stalk should in general be avoided."

H. H. LAMSON,
Bacteriologist.

DEPARTMENT OF ENTOMOLOGY.

During the past year the work of the department of entomology has consisted of studies of the life histories of various injurious insects and the methods of controlling them, of an investigation of the food relations of certain birds, especially the chickadee and the chipping sparrow, and of experiments with various insecticides. In addition the formation of a collection of New Hampshire insects has been continued, and the inquiries of many correspondents have been answered. The more important entomological events of the year are mentioned in the following Insect Record, although we have studied several insects not there included. In nearly all this work efficient aid has been rendered by Mr. W. F. Fiske, assistant entomologist.

THE INSECT RECORD FOR 1898.

Much the most important item in the record of insect injury for the year in New Hampshire is that of an exceed-

Digitized by Google

ingly destructive outbreak of the FOREST TENT CATERPILLAR (*Clisiocampa disstria*), which extended over a large part of the state. This was a continuance of the irruption of this insect noted in the insect record for 1897,* although as was to be expected the outbreak this year was more serious and extended over a wider area. The caterpillars were most abundant in the western part of the state, especially in the Connecticut valley, where extensive forest areas were defoliated by them. For, unlike the common AMERICAN TENT CATERPILLAR (*Clisiocampa americana*), this forest species does not as a rule confine its attack to three or four sorts of trees, but feeds upon the foliage of nearly all deciduous species. The nearly full grown caterpillar is represented in Fig. 7. As will be seen by comparing this picture with Fig. 8, which represents the American Tent Caterpillar, the two species are similar; but they may easily be distinguished by the differences in the markings of the line along the middle of the back. In the forest caterpillars this line is interrupted, consisting of a series of markings like that shown in the middle of Fig. 7 *a*, while in the common tent caterpillar the line along the middle of the back is continuous.

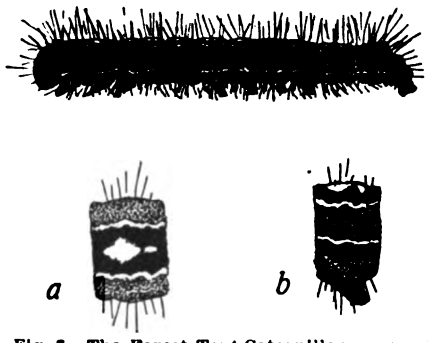


Fig. 7.—The Forest Tent Caterpillar : *a*, markings on one ring of the back; *b*, markings on one ring of the side.

These caterpillars have attacked nearly all kinds of deciduous trees, causing special damage to shade trees like the elm and maple. Many sugar orchards appear to have sustained injury that will lessen their productiveness in the immediate future. As a rule, the attack appears to have been more

* Bulletin 48, p. 142.

Digitized by Google

severe in the towns and villages than in the country. These larvæ hatch from the eggs a week or more later than the common American tent caterpillars, and there is considerable variation in the time of hatching within the species itself. In a given region caterpillars of various sizes could easily be found late in May or early in June. They feed upon the leaves in all parts of the trees, having a preference apparently for the upper branches. They very commonly eat out the blade of the leaf along the side of the midrib, severing the marginal part so that it falls off; these severed portions were to be found abundantly on the ground beneath the infested trees. The result of this peculiar mode of attack is of course greatly to increase the damage done for the amount of leafage actually consumed. A bulletin giving a full discussion of the life history and remedies for the forest tent caterpillar, is in preparation for publication before next spring.

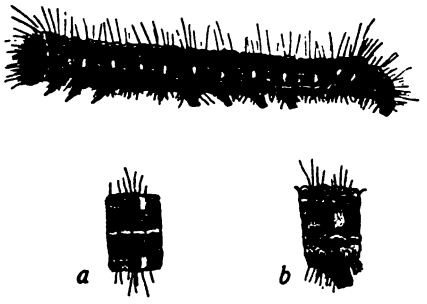


Fig. 8.— The American Tent Caterpillar : *a*, markings on one ring of the back; *b*, markings on one ring of the side.

A more encouraging statement may be made concerning the AMERICAN TENT CATERPILLARS. (*Clisiocampa americana*) which have been regularly destructive for several seasons past, for in some localities at least there are indications that they will be less abundant next year. In the region about Durham there were heavy and long continued rains during the time when the caterpillars were hatching from the eggs and before they had time to spin for themselves a protecting web. The result was that a large proportion of the young larvæ

Digitized by Google

were washed away or destroyed. As a rule only those survived which were able to shelter themselves on the under surface of the twig to which the egg mass was attached. Conse-

Fig. 9.—American Tent Caterpillars killed by disease.

quently, at the beginning of the season there was a considerable reduction in the numbers of the caterpillars. The survivors, however, developed in sufficient abundance to be decidedly in evidence in May, but during the last weeks of their growth there appeared among them a bacterial disease, a sort of insect cholera, which killed them in vast numbers. The effectiveness of this disease was doubtless increased by the wet weather prevailing at the time. Early in June nearly every nest was full of the dead and dying caterpillars, those upon the outside of the web hanging limp and lifeless at first (Fig. 9), and then gradually shriveling up until only the dried skins told of their presence. A series of observations made upon a large number of nests just before the period of pupa-

Digitized by Google

tion showed that more than ninety per cent of the caterpillars present had been killed by this disease. As a result there were few caterpillars crawling along the roads in early June. although during previous seasons great numbers were to be seen at that time. There were also comparatively few moths to be found later, and the egg masses of the next year's brood are correspondingly reduced in numbers, although there are still enough of these eggs upon the trees to yield a goodly crop of caterpillars next season.

Fig. 10.—Leaf of Black Cherry eaten by Forest Tent Caterpillar.

We tried many experiments with remedies for the American Tent Caterpillar, although but little new information was brought out. The careful use of a small amount of kerosene, a teaspoonful to a nest, in wetting the silk of the tent, was found a satisfactory way of killing the partially grown caterpillars. But great care is necessary, as, if sufficient kerosene is added to saturate the bark, the tree is injured. If the web away from the bark is lightly dampened the caterpillars come in contact with it as they pass in and out of the nest and are killed.

One of the most satisfactory remedial measures for these tent caterpillars that has come to my notice related to the removal of the egg masses. In Newfields, N. H., the Village Improvement Society offered the children in the schools ten cents a hundred for all the egg masses or

Digitized by Google

"caterpillar belts," as they were aptly called, brought in. Many of the children worked faithfully, and when, in February, the writer was called in to point the moral of the lesson, 8,250 egg masses were shown as the result of their endeavors. I doubt if the expenditure of $8.25 by a village improvement society often does more good than was done in this case. The caterpillars were destroyed, the effect being easily noticeable in the spring and early summer, while the boys and girls had a remarkable lesson in nature study.

Fig. 11.—Egg-mass of American Tent Caterpillar.

Several complaints reached the station during the summer concerning black spiny caterpillars that fed in colonies on the elm trees, often defoliating good sized branches. Whenever specimens accompanied the complaint, the insect proved to be the larvæ or caterpillars of the ANTIOPA BUTTERFLY (*Euvanessa antiopa*), a species which is more or less abundant every season. These butterflies are justly regarded as among the most beautiful of our insects; the wings are a rich purplish black color with a creamy border running along the outer margin. They may be found late in autumn or early in spring flying by the roadside or in open glades in the woods; and occasionally during the intervening months one who looks beneath culverts or bridges, or in some loose pile of boards, will come across one of these butterflies passing the winter in a situation where it is exposed to the lowest temperatures. If in cold weather such a butterfly be brought into a warm room it will gradually become active. In spring eggs are laid by the females in clusters upon the twigs of elm, willow, and poplar trees, the eggs soon hatching into caterpillars that feed upon the foliage. The caterpillars remain together more or less as a colony, so that their presence is soon indicated by the bare twigs that they leave behind them. When they become full grown, they seek shelter of some sort,

Digitized by Google

where each changes to a chrysalis, to emerge soon afterward as a fully developed butterfly. There are two broods each season.

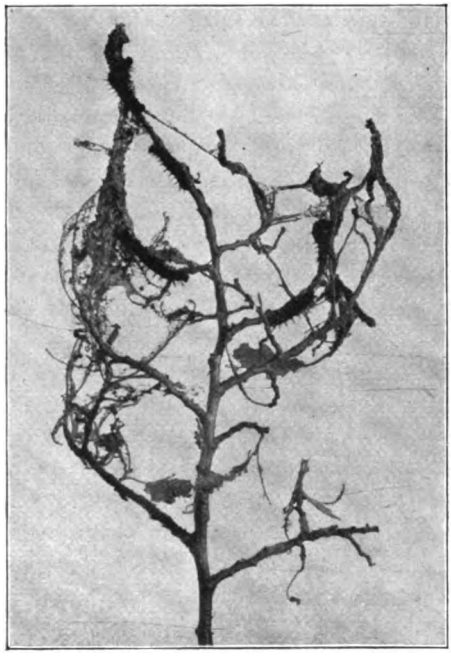


Fig. 12.— Elm twig showing work of Antiopa Caterpillars.

These colonies of caterpillars are usually so conspicuous that it is an easy matter to cut off the branch on which they are feeding, and to crush them. Some of the caterpillars, the defoliated twig, and the slight silken web they make while they are at work are represented in Fig. 12.

Another insect attacking fruit and shade trees, which was extraordinarily abundant this year, was the FALL WEB WORM (*Hyphantria cunea*). The unsightly webs of these caterpillars, during the late summer and early autumn, festooned a large proportion of the orchard trees in southern New Hampshire. To many young trees these caterpillars must have

Digitized by Google

caused serious injury. In another place* I have summarized the life history of this species, as follows:—The adult is a pretty white moth which deposits eggs on the leaves of various trees early in summer. These soon hatch into young caterpillars that begin at once to spin a protective web. The young worms are of a pale yellow color, sparsely clothed with hairs, and have a black head and two rows of black marks upon the body. They feed upon the parenchyma of the foliage, leaving the network of veins, and grow quite rapidly, enlarging the web as they develop. By the time they are full grown a single colony of them will destroy the foliage of a good sized branch, making it very conspicuous on account of the web-like covering. At this time the larvæ are a little more than an inch long, with the body densely clothed with yellowish hairs. They now leave their nests and descend to the ground, where just beneath the surface, or under some suitable shelter above the surface they spin slight silken cocoons, within which they change to the chrysalis state. At the north there is but one brood each year, but in the southern states there are two.

The webs of this insect are so conspicuous that it is an easy matter to cut them off and burn or crush the larvæ. This is a simple remedy, and the earlier that it is done the better. A little careful work in removing these webs when they first appear early in August will greatly improve the looks of the orchard, as well as increase its productiveness in following seasons. The caterpillars are then clustered together on one or two twigs, and may readily be crushed or burned.

Early in September there appeared in the vicinity of Durham an incipient outbreak of an insect that may be called the RED-HUMPED OAK CATERPILLAR, as it has not heretofore received a common name. In entomological literature it has generally been known by its scientific name, *Edema albifrons*,† although it has been so rarely destructive that the necessity

* Insects and Insecticides, p. 201.

† This species has lately been placed in the genus *Symmerista*, and technically it is now called *Symmerista albifrons*.

Digitized by Google

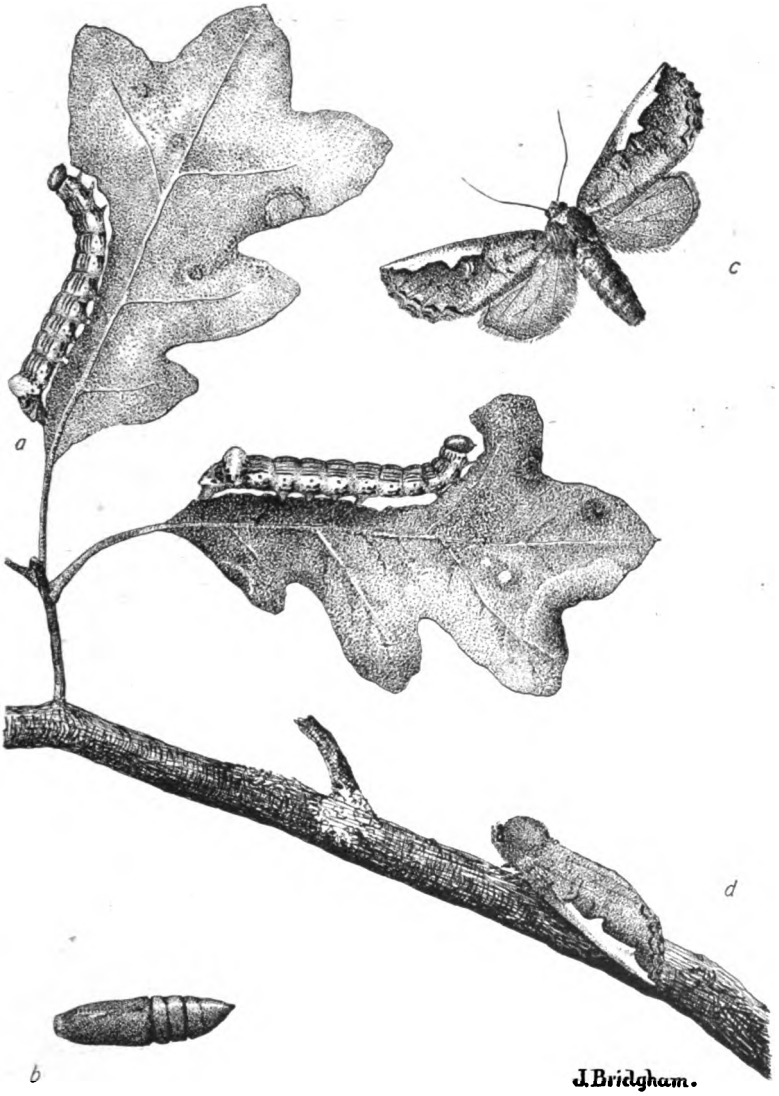


Plate I.—The Red-humped Oak Caterpillar: *a*, larva; *b*, pupa; *c*, moth, wings expanded; *d*, moth at rest.

Digitized by Google

for a common name has not been recognized. When full grown this caterpillar is nearly two inches long, and of the general form represented in *a* of Plate I; the head is reddish brown, while the body is striped longitudinally with black, yellow, and whitish. Near the hind end there is a prominent reddish hump, the presence of which has led to the proposal of the common name mentioned above.

These caterpillars feed upon the leaves of the various species of oak, eating the blades and leaving the midribs. In this process good sized pieces of the leaves are commonly detached to fall to the ground, where they were very abundant in the infested woods. When the caterpillars become full grown—from the middle to the last of September—they descend to the ground, where beneath the fallen leaves they pupate in a slight cocoon. The pupa is brown, and of the shape represented in Fig. *b* of the plate. The following spring the pupæ develop into greyish moths, similar to the one represented in *c*. These moths rest during the day upon oak twigs, being rendered inconspicuous by their resemblance to a growth on the twig.

These red-humped oak caterpillars are seldom injurious. One reason for this is to be found in the fact that they are greedily devoured by the common ruffed grouse or partridge, which frequents the open woods where the caterpillars occur. In a study of the food of this bird the present season, Mr. Ned Dearborn of this college has found that a large part of the food in September consisted of these caterpillars, as many as sixteen of them being found in a single stomach.

During the early summer inquiry was repeatedly made concerning two of our largest and most beautiful moths, which seemed either to be unusually abundant, or else to attract more than ordinary attention. The first of these is the large dark brown moth, the side view of which is represented in Fig. 13. When its wings are spread they commonly expand about five inches from tip to tip, the body of the insect being nearly an inch and a half long. On the front end of the body are two large feathery feelers or antennæ. On each of the wings near the middle there is a whitish or brownish cres-

Digitized by Google

cent-like spot, while a wavy line, similar in coloration, runs along each wing nearly parallel with the outer margin and about three fourths of an inch from it. Near the tip of each front wing there is an oval black spot with a small white crescent on its inner edge. The body is of a brick red color, with rings of white and dark brown on each segment of the abdomen.

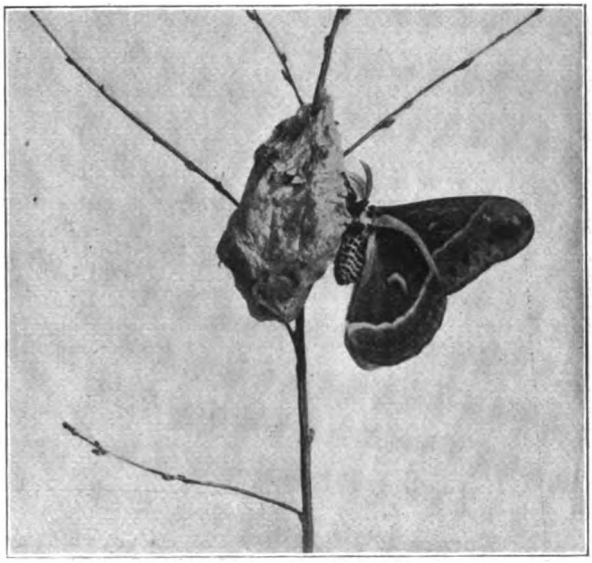


Fig. 13.—The Cecropia Moth and its Cocoon (reduced).

This moth, which is called the CECROPIA MOTH, being known to science as *Samia cecropia*, emerges from a large silken cocoon, like that shown in Fig. 13. These cocoons may be found in winter upon a variety of trees and shrubs; if brought in doors and kept in a cool room, they will yield the moth in the early summer. When at liberty these moths deposit their eggs on many sorts of fruit, forest, and shade trees, the eggs hatching into caterpillars that feed upon the foliage of the tree. The caterpillars grow during the summer, and early in autumn spin the large loose silken cocoons, within which

Digitized by Google

they change to pupæ to remain throughout the winter. In New England this species is seldom if ever sufficiently abundant to do serious injury.

The other moth referred to above may fairly claim to be our most beautiful insect. By the great Linnæus it was named the LUNA MOTH (*Actias luna*), and has long been known as the Queen of Night. Its general appearance is well

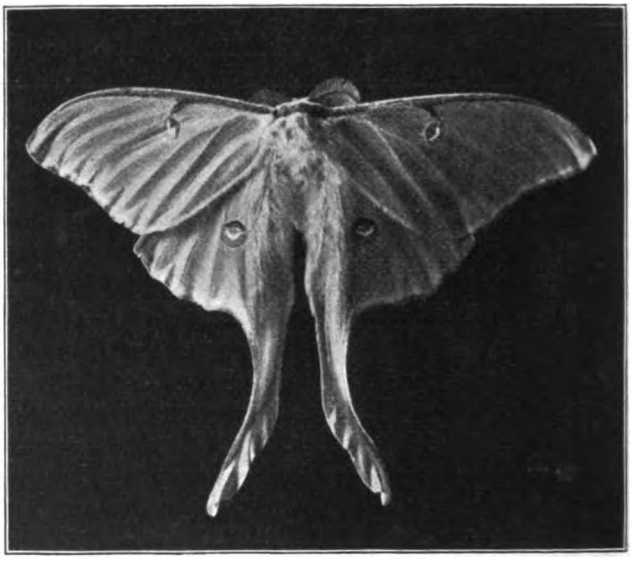


Fig. 14.— The Luna Moth (slightly reduced).

shown in the photograph reproduced in Fig. 14, the wings expanding fully four inches, and the colors being a delicate green margined with greenish yellow along the posterior edges, and a delicate purplish brown along the front border. This species also appears in early summer, occasionally flying at night into open windows of lighted rooms, where its size and beauty are sure to attract attention. Its life history is quite similar to that of the Cecropia moth. The eggs are deposited on the leaves of various trees; the caterpillars feed upon the foliage, and late in summer or early in autumn spin their

Digitized by Google

tough, oval, silken cocoons on the ground beneath their host plant. There they remain until the warmth of the succeeding spring calls them to life, when they come from the cocoons as marvels of insect beauty. The caterpillars are seldom seen, and in New England at least they are never destructive to a serious extent.

The ROSE BEETLE (*Macrodactylus subspinosus*), or ROSE CHAFER, appeared in June, though in numbers conspicuously less than usual. On the college grounds the attack of this insect was most severe upon the young hydrangea shrubs, the leaves of which were eagerly devoured by the beetles, leaving only a framework of veins. (Fig. 15.) A number of substances were applied to check the injuries of the pests, but nothing was found so simple and effective as that of brushing them into a pail or pan holding a little water, on the surface of which is a little kerosene. This is to be done in the cooler part of the day when the beetles are more sluggish than in the warmer hours.

Fig. 15.— Leaf of Hydrangea eaten by Rose Beetles.

Several inquiries have been received during the year regarding a safe and effective remedy for the CABBAGE WORM (*Pieris rapæ*), which the present season has been at least as destructive as usual. In some parts of the country the practice of applying Paris green or other arsenical poisons to young cabbages has apparently been on the increase, the method having received the endorsement of a number of entomologists. It has been argued that there is no danger to the consumer because the amount of poison applied is so small, and as it is to be put on only when the plants are young before they have begun to head, the leaves to which it is applied will not be eaten. There is little doubt that the argument is sound,

Digitized by Google

were it certain that the poison would only be applied under the conditions recommended. But the work must so often fall into the hands of ignorant and unskilled laborers, that the element of danger cannot be ignored. The first positive evidence of the danger that I have seen came to me in a letter from a correspondent at Hill, New Hampshire, who reported that he had known a case in which the members of a family had been made ill by eating cabbages which had been treated with Paris green.

We tried a large number of experiments with pyrethrum or insect powder as a remedy for the cabbage worm. This is one of the most important of the non-poisonous insecticides, killing caterpillars and other insects by merely coming in contact with their bodies. It was found to be effective when applied dry by means of a bellows, either undiluted, or thoroughly mixed with an equal quantity of flour. It also kills the worm when applied as a decoction made by adding one ounce of pyrethrum to one gallon of boiling water. Much less pyrethrum was required for a given area when it was put on in this way, than when it was used as a dry powder. The decoction is to be applied as a spray, either by means of an atomizing bellows, or a pump and spray nozzle. We also found that a one per cent solution of the Rose Leaf insecticide, a tobacco extract made by the Louisville Tobacco Company effectually kills the worms at a small expense.

The various stages in the life history of this cabbage worm are illustrated in Plate II. The adult insect is the common white butterfly, the male of which is shown at *c*, and the female at *d* of the plate. The latter deposits, singly, or in clusters of two or three each, small yellow eggs upon the cabbage leaves; these soon hatch into little green larvæ that feed upon the substance of the foliage. In about two weeks they become full grown, when they generally leave the cabbage plants, and finding some suitable shelter—beneath a board or under a coping of a fence,—change to chrysalids. They remain in this condition about ten days, when they emerge as butterflies, to lay eggs for another brood of worms. The winter is passed in the chrysalis state. There are several

Digitized by Google

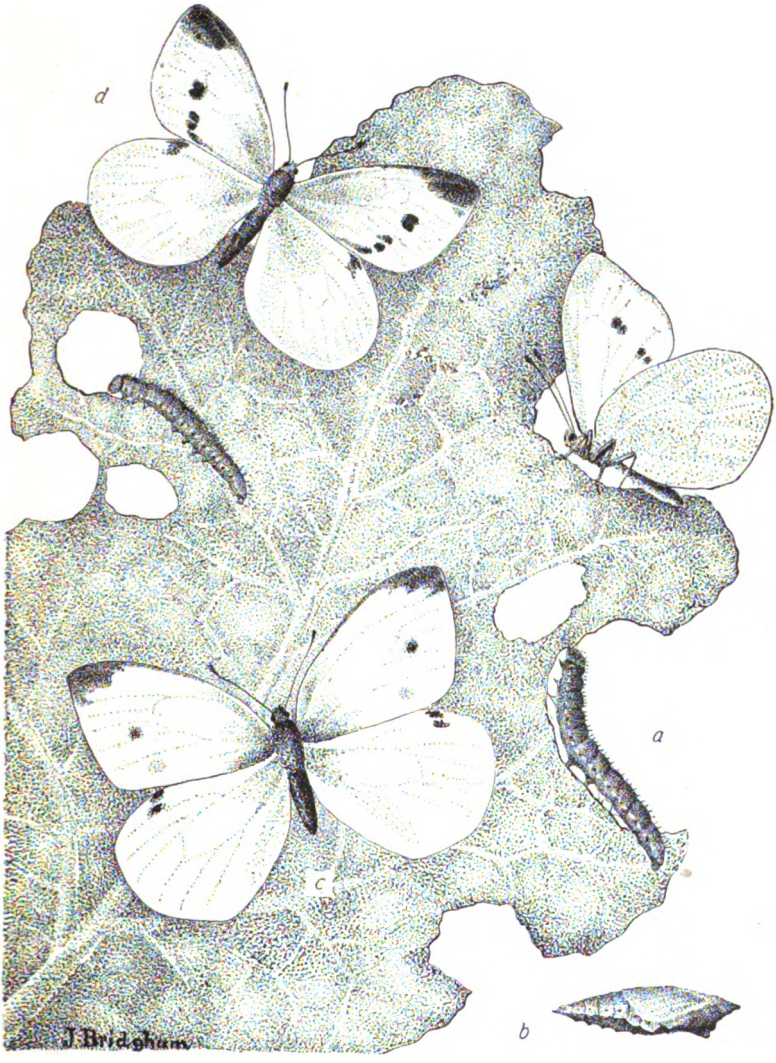


Plate II.— The Cabbage Butterfly: *a*, larva; *b*, chrysalis; *c*, male butterfly; *d*, female butterfly.

Digitized by Google

generations of larvæ each season, the number varying with the season and latitude.

During the spring numerous complaints were received regarding the injuries of the BEAN-WEEVIL (*Bruchus obtectus*), which appear to have been unusually severe. The presence of this insect is indicated by the small excavations which the larvæ make in the beans similar to those shown in Fig. 16 *c*. The fully developed weevil considerably magnified is represented at *b* of the same figure, its natural size being indicated at *a*. In the field these weevils deposit eggs inside the green pods in small clusters. In a short time the eggs hatch into tiny grubs that feed within the beans, maturing in about a month. These insects are also able to develop in dried beans, so that when they are present in beans put away in autumn, many more may be present the following season. The best way of preventing such a continuance of their injury seems to be to inclose the infested beans in a tight vessel in which a little bisulphide of carbon, benzine, or gasoline has been placed. The fumes of these volatile substances will destroy the beetles. Of course care must be taken that no fire comes in the vicinity of the treatment.

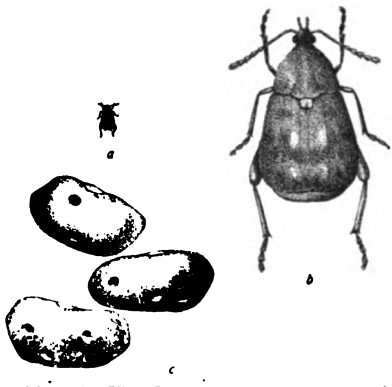


Fig. 16.—The Bean-Weevil: *a*, natural size; *b*, enlarged; *c*, beans from which beetle has escaped.

In the bulletin on the Canker Worm (No. 44) attention was called to the value of a substance called Raupenleim as a substitute for printer's ink in banding orchard trees. Letters received during the present year have shown that this substitute has been used with a great saving of the expense involved in the use of ink. The Raupenleim has been used in large quantities by the Gypsy Moth committee in Massachusetts. During a recent conversation with these officials I learned

Digitized by Google

that there is sometimes danger in applying this substance to young and smooth barked trees, from the material penetrating the inner bark and killing the growing cells. Consequently I would recommend, in the case of young trees as well as those older which have a smooth bark that if Raupenleim be applied it be placed on strips of thick paper tacked to the trees. Even in the case of bearing apple trees this would probably be the safer method, and it should always be adopted for peach trees, if not for pear trees also. After the Raupenleim has been on some weeks the surface hardens into a crust, and it is advisable to scrape off this crust after the danger from canker worms is past. Too much of the rough bark should not be scraped off of the older trees to which the band of Raupenleim is to be applied, unless paper is to be used.

Less than the usual amount of injury was done this season by the apple worm, the larva of the CODLING MOTH (*Carpocapsa pomonella*). This immunity was probably due in part at least to the small apple crop of the last year. There has also been but little complaint regarding the APPLE MAGGOT (*Trypeta pomonella*), or Railroad Worm. The SQUASH BUG (*Anasa tristis*), STRIPED CUCUMBER BEETLE (*Diabrotica vittata*), and various flea beetles have been about as destructive as usual, while the SUGAR MAPLE BORER (*Glycobius speciosus*), treated of in Bulletin No. 33 of this station, is continuing its destructive work in many parts of the state. Little injury, however, has been done by the WHITE MARKED TUSSOCK MOTH (*Orgyia leucostigma*) discussed in the same bulletin. The PEAR SLUG (*Eriocampoides limacina*) was somewhat destructive in the southern part of the state. The HORN FLY (*Haematobia serrata*), or Texas fly, has been reported as very troublesome at Franklin Falls.

CLARENCE M. WEED,
Entomologist.

Digitized by Google

DEPARTMENT OF METEOROLOGY AND AGRICULTURAL ENGINEERING.

1897-'98.

I. METEOROLOGY.

Observations have been continued the past year as heretofore under the charge of James A. Foord, New Hampshire College, class of '98, who has been assisted for a portion of the year by William F. Fiske, special student in biology.

Signal flags have been displayed each day, except Sundays, throughout the year from the tower of the experiment station building, indicative of the weather for the succeeding night and day. In addition, a synopsis of weather conditions has been written each day upon the blackboard at the station building for the benefit of the station workers.

Another year has been characterized by a large precipitation, and it is like the last in having this precipitation quite uniformly distributed throughout the year. There has been no suspicion of drought, and the soil has been moist continuously. The least number of rainy days in any month was five, the same as for the year preceding. The total rainfall was seven inches less than for the previous year, chiefly because of the absence of such remarkable storms as those of September 6, 1896, and June 10, 1897. The mean temperature of the summer months of 1897 was about normal, but there was a notable lack of extremes. Only one hot spell occurred in July, not one in August, and one in September. No one was of great length or of excessive severity. July was the wettest month of the year, judged by its total rainfall. In both July and August the weather was very catchy, so that it was almost impossible to cure hay seasonably or well. It was frequently remarked that nothing like it was remembered by the oldest inhabitant. The result was a large crop of very poor quality of hay. Other crops were backward, but the long season helped them out so that a fair harvest was reaped. No killing frost occurred till near the close of September.

Digitized by Google

October averaged warm, owing chiefly to warm days indicated by an unusually high mean maximum. It was the driest month of the year, with only one half inch of rainfall and five rainy days.

November has some claim to be considered the wettest month as it stands first in number of rainy days, and second in total precipitation. It was as much colder than the average as October was warmer, contrary to expectations based on difference in rainfall. The last week was unusually cold for the season.

December temperature was medium warm. No snow of any amount came to stay till the last day of the month. Upon the sixteenth all frost came out of the ground, and the unseasonable spectacle was presented of numerous people plowing upon December 17.

January was a normal month in all respects. Three cold spells were noted, but they were all, with possibly one exception, of a mild order. Sleighing was continuous through this as well as the following month.

February came in with a driving snowstorm, that came near being a record breaker. Not even an engine passed this railroad station for twenty-four hours, and on the second day trains were one to three hours late. It was more the fury of the wind than the amount of snow that caused the total stoppage of traffic. The precipitation and temperature for the month were medium. Only one sustained cold spell occurred and this was not excessive.

March was unseasonably warm with a small precipitation, while opposite conditions prevailed in April, thus showing a second time in one year unexpected monthly combinations of high temperature with small precipitation and the reverse.

May was a wet month with fourteen rainy days. The old saying, "A wet May for hay," proved a true prophecy.

The precipitation for June was also abundant though not excessive, and the making of a large hay crop was thus assured. Other crops were backward on account of the wet spring, but on the whole made a good growth.

Digitized by Google

A summary of the observations taken will be found appended.

II. Agricultural Engineering.

Progress has been made during the year in extending the bounds along the highway in front of college property. Stone posts have been set and located where necessary between the corner of the President's lot, next to Professor Rane's house, and the Louisa Smith lot on Main street; also, upon Madbury street as far as the Silas Jenkins lot, except that the location of the north line of the dormitory lot next to the Louisa Smith lot has not yet been fully adjusted.

The steam drill belonging to the college was employed late in the fall of 1897 to complete the excavation of stone in the field west of the railroad station. The stone, however, were not moved away till spring, a derrick being then set up to assist in the work.

Experiments in road surfacing of quite extensive character were carried on during the spring of 1898, the details and results of which will appear in due time in bulletin form.

Class instruction was carried on in connection with the use of the steam drill, the derrick, and different materials

Road conventions at Keene, N. H., and Vergennes, Vt., have been attended during the year, and numerous talks upon road construction given at other places.

C. H. Pettee,
Meteorologist.

Digitized by Google

METEOROLOGICAL SUMMARY.

	Average temperature.		Precipitation.*		Snow in inches.		No. days .01 inch precipitation.		1897–1898.			
	1896-1897.	1897-1898.	1896-1897.	1897-1898.	1896-1897.	1897-1898.	1896-1897.	1897-1898.	Prevailing wind direction.	Days clear.	Days partly cloudy.	Days cloudy.
July	70	69	2.85	6.96	.....	.....	11	9	E.	9	9	13
August	67	66	3.68	2.99	.....	.....	9	10	W.	15	12	4
September	58	59	9.48	2.71	.....	.....	11	8	W.	15	5	10
October	46	49	2.50	.49	.....	.....	13	5	W.	15	10	6
November	40	36	3.47	6.79	1.7	5.5	8	16	N. W.	10	6	14
December	24	27	1.76	5.33	3.5	14.2	5	10	N. W.	10	3	18
January	23	21	4.84	3.59	17.7	32.0	9	7	N. W.	14	6	11
February	25	26	2.31	3.03	13.5	17.0	5	8	N. E.	9	6	13
March	32	37	4.40	1.56	12.0	8.5	10	7	W.	17	6	8
April	46	41	2.50	5.39	.....	7.0	11	13	N. W.	12	6	12
May	55	55	4.94	3.79	.....	.....	10	14	S. E.	12	9	10
June	60	65	8.85	2.14	.....	.....	11	12	S. E.	11	12	7
Sum	546	551	51.6	44.8	48.4	84.2	113	119	W.,N.W.	149	90	126
Mean	45.5	45.9										

*Including rain, hail, sleet, and melted snow in inches.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

BULLETIN

OF THE

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

1898

NUMBERS 49 TO 59

AND

TENTH ANNUAL REPORT.

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

PRINTED BY
ARTHUR E. CLARKE, PUBLIC PRINTER
MANCHESTER, N. H.

Digitized by Google

CONTENTS.

INSPECTION OF FERTILIZERS IN 1897 1
List of Towns Visited 3
List of Manufacturers 4
Composition of Mixed Fertilizers 6
Trade Values of Ingredients 13
Fertilizer Notes for 1897 14
Fertilizer Laws of New Hampshire 17

DEHORNING CATTLE 19
Experience with the College Herd 21
Conclusions 25
Preventing the Growth of Horns 27
Directions for Using Caustic Potash 29

SWEET CORN FOR NEW HAMPSHIRE 31
Introduction 33
Variety Tests 36
Notes on Varieties 41
Summary 45

GROWING MUSKMELONS IN THE NORTH 47
Introduction 49
Experience at this Station 51
Comparison of Varieties 54
Characteristics of Each Variety 60
Notes on Varieties 62
Partial Summary 69

THE FARM WATER SUPPLY 71

THE WINTER FOOD OF THE CHICKADEE 83
Introduction 85
Results of Investigation in Detail 88
Abundance and Feeding Habits 95
Conclusion 98

THE FEEDING HABITS OF THE CHIPPING SPARROW . . . 99
Introduction 101
The Record in Detail 103
Summary and Conclusion 109

Digitized by Google

CONTENTS.

THE POISONOUS PROPERTIES OF WILD CHERRY LEAVES . 111
Introduction 112
The Wild Cherries of New Hampshire 113
Analysis of the Leaves 118
Conclusions 123

EXPERIMENTS WITH ROOTS AND FORAGE CROPS . . . 125
Forage Crops 127
Gramineous 128
Leguminous 135
Miscellaneous 145
Root Crops 149

COST OF RAISING CALVES 157

TENTH ANNUAL REPORT 169

Digitized by Google

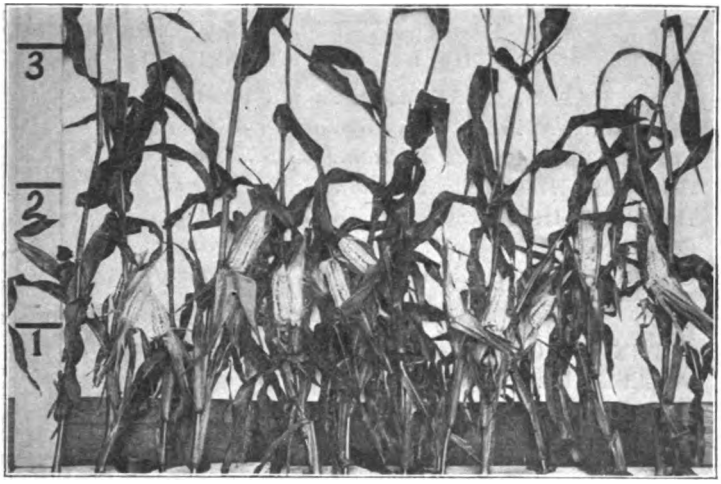
Sci 1636.35

Bulletin 60 January, 1899

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

GREEN CORN UNDER GLASS



BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

BOARD OF CONTROL

HON. FRANK JONES, *Chairman*, Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHAS. S. MURKLAND, *ex-officio*, Durham.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
FRANK WM. RANE, B. AGR., M. S., *Horticulturist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. SC., *Entomologist.*
CHARLES W. BURKETT, M. SC., *Agriculturist.*

ASSISTANTS

ELWIN H. FORRISTALL, B. S., *Assistant Agriculturist.*
WILLIAM F. FISKE, *Assistant Entomologist.*
ARTHUR GIVEN, B. S., *Assistant Chemist.*
CLEMENT S. MORRIS, *Clerk.*

BULLETINS OF 1898

Bulletin 49—Inspection of Fertilizers. January.
Bulletin 50—Dehorning Cattle. February.
Bulletin 51—Sweet Corn in New Hampshire. March.
Bulletin 52—Growing Muskmelons in the North. April.
Bulletin 53—The Farm Water Supply. May.
Bulletin 54—The Winter Food of the Chickadee. June.
Bulletin 55—The Feeding Habits of the Chipping Sparrow July.
Bulletin 56—Poisonous Properties of Wild Cherry Leaves. August.
Bulletin 57—Experiments with Roots and Forage Crops. September.
Bulletin 58—Cost of Raising Calves. October.
Bulletin 59—Tenth Annual Report. November.

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

Digitized by Google

FIG. 2.—Lettuce house in which the corn was forced. The center bed is well adapted for a corn crop.

Digitized by Google

FIG. 3.—A crop of sweet corn with ears formed. College greenhouse, 1897.

Digitized by Google

GREEN CORN UNDER GLASS

BY FRANK WM. RANE

The forcing of sweet corn is practically unknown. That this crop can be grown under glass and if properly handled be profitable, I believe we are able to demonstrate. The idea that it was possibly adapted for forcing occurred to the writer when studying the root development of corn under glass. The corn grown at this time surprised us by its developing very fair sized nubbins under what might be termed very unfavorable conditions.

During the season of 1896-7, the only house available for the experiment was a large vegetable house, 25 x 100 feet; and as lettuce, cauliflower, etc., which demand a low temperature, are grown in this house during the fore part of the season, the sweet corn was not planted until April, when these crops were marketed.

The nature of the greenhouse is very important, as it is necessary that the plants have sufficient room for development. The house ordinarily used for lettuce and cucumbers in New England answers very well, while those filled with benches would not do. The plants vary according to the variety from four to eight feet in height. The house used in the present experiment has ground-floor beds, as shown in the photographs, and the center bed, which is 15 x 88 feet, is six feet from the glass at its nearest point, while the average is seven and one-half feet. The corn was planted April 10 and matured July 6. While we have not grown an extensive crop in midwinter, our results from the corn fruited in experimental boxes lead us to believe that with proper culture an entire house devoted to this crop would be highly successful.

Sweet corn does not appear in the Boston market until about

Digitized by Google

the middle of July. At that time it brings good prices and the entire product is from the south. In order to test the market a small shipment was made to a leading commission house in Boston on July 6, 1897. Its value could not be definitely determined, however, since owing to the fact that it was not on the market, there was no fixed price. The only quotations and data relating to sweet corn we have found, have been the following, taken from the files of *Garden and Forest*. They are for the New York wholesale market for the past five years:

June 24, 1893. "Green corn from the south is 60 cents a dozen ears."

July 4, 1894. "Green corn is in the market from New Jersey."

June 19, 1895. "The first Lima beans of the season are now coming from Florida and sugar corn is also received from the same state."

June 24, 1896. "Corn is now coming from southern New Jersey and costs fifty cents a dozen."

June 30, 1897. "Special consignments of small lots of sugar corn have been received from the south for a month past, but these have been sold directly to a few of the best hotels, and not opened up in the market at all. On last Saturday the first corn from Delanco, New Jersey, sold in Washington market at sixty cents for a dozen ears."

From this it is readily seen that if the New York market does not get sweet corn until these dates, Boston and other Northern cities are likely to be without it until much later. Without any sweet corn on the market therefore before July, we have a rather long period even in spring, when this vegetable has no competition. While it has no established market price at present in our cities, it naturally follows that like other forced greenhouse crops, the returns should at least be in proportion to its cost, and doubtless until commonly grown would be much more profitable. Sweet corn when first in season is doubtless as highly prized as any other of the green vegetables; and taking this fact into consideration, we believe that when offered out of season it will be in great demand.

Digitized by Google

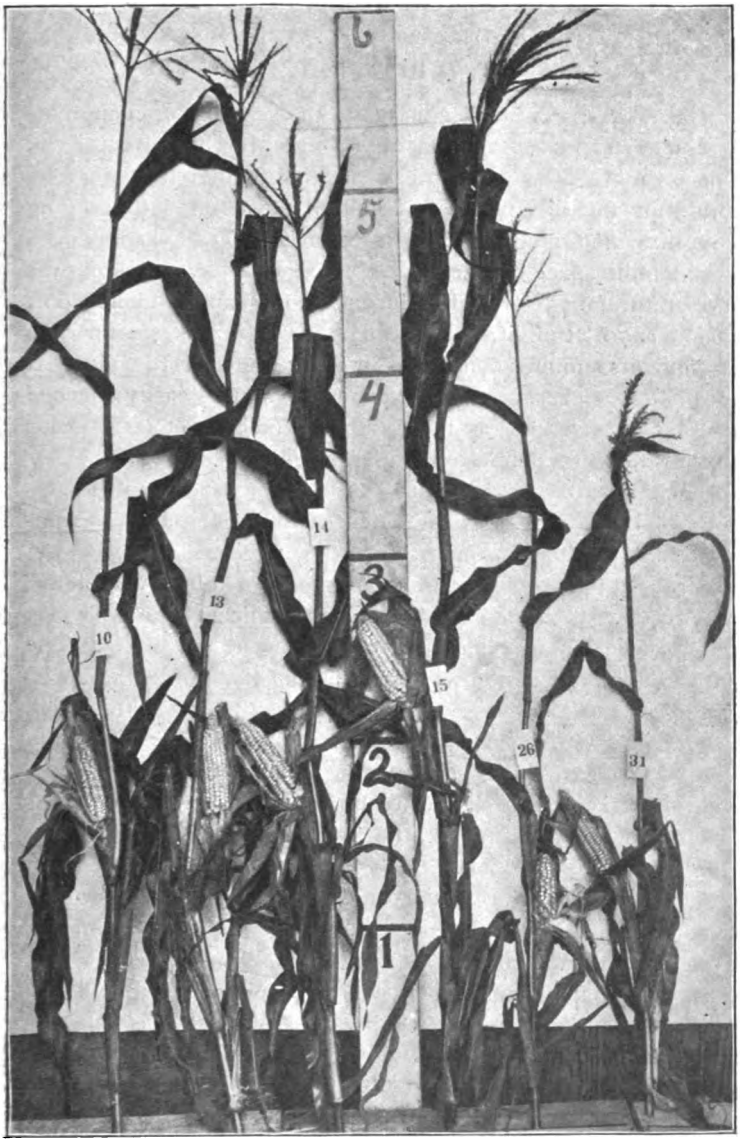


FIG. 4.—Varieties.

10. Early Minnesota.
13. Crosby's Early.
14. White Cob.
15. First of All.
26. Early Fordbrook.
31. Adams's Extra Early.

Digitized by Google

THE HOUSE, AND METHODS OF TREATMENT

The House.—A house adapted to the growing of cucumbers or tomatoes trained to one stem, should grow sweet corn. The ordinary New England lettuce-house therefore answers admirably for this purpose. The plants being tall, ranging from three and one-half to eight feet according to variety, need considerable space overhead. A house capable of holding the temperature of 75° or higher during the day, and not below 60°, or better, 70° at night, is desirable. Even out of season corn demands its summer conditions in order to get best results. It does not, however, seem to be as tender and as easily checked as other plants, such as the egg-plant, melons, etc. It needs all the sunlight; therefore the glass needs no shading.

Fig. 2 is a photograph taken of the house used in this experiment. It was taken when the first crop of lettuce was coming off the present season.

Soil.—Any good fertile greenhouse soil will be favorable for sweet corn. Unlike many of the more delicate plants, it is a ravenous feeder provided other conditions are favorable. The soil in which our plants were grown was that mixed and used for forcing head lettuce,—a rather light sandy loam, with which all greenhouse men are acquainted. For the novice I would recommend a visit to a house forcing head lettuce, or he may find full directions in literature on forcing. After two crops of lettuce had been taken off, the corn was planted without supplying further plant food.

Our beds are on the ground and therefore much deeper than the ordinary raised bed, although we renew only about the same depth of soil from year to year, usually used in the raised ones. Ordinarily it probably would be advisable to add and mix in well some complete fertilizer. After a study of the development of corn roots, I am convinced that the plant will not suffer for food as long as there is any available about it.

Sowing and Transplanting.—Much time is gained by soaking the seed before planting as in this way they germinate more quickly. Should space be very scarce or the crop preceding rather late, the corn may be started in flower-pots and then transplanted. Care should be exercised, however, in so

Digitized by Google

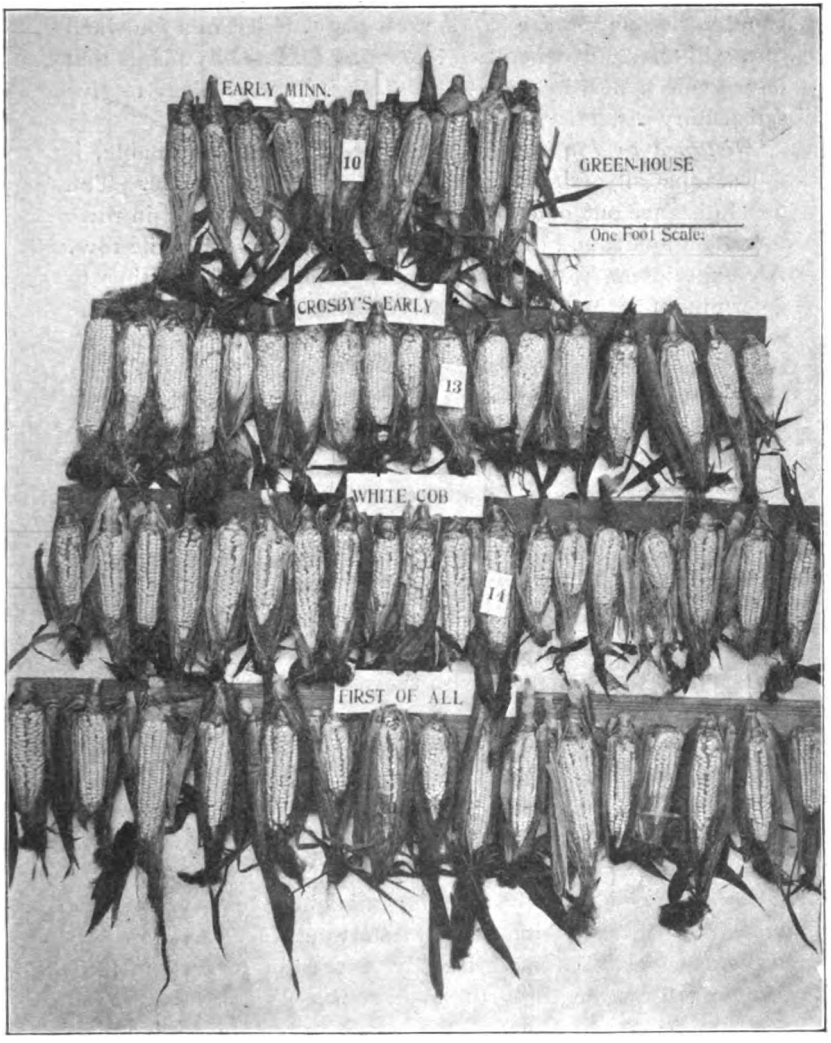


FIG. 5.—Average size and appearance of four of the varieties.

Digitized by Google

doing; for should the plant become root-bound, it will be stunted. They should be shifted from smaller to larger pots should occasion require it. A corn plant, if left in a four-inch pot, will tassel out when two feet or so tall. Only plants that have made a healthy growth from the first are likely to give satisfactory results.

Distance to Plant.—As space under glass is valuable, it follows that all of it must be utilized as far as possible. The usual distance out of doors for average sweet corn is in rows three feet apart, and the plants nine inches apart in the row. An experiment was undertaken at the time of planting to determine the most economical distance for planting in the forcing-house. Six plots were planted as follows: In plots 1 and 2, the rows were 18 inches apart; in plots 3 and 4, rows 2 feet apart; in 4 and 5, rows 3 feet apart. All of the plants were nine inches apart in the row. At maturity it was found that from plots 1 and 2, the plants averaged one ear per stalk; from 3 the average was .9 ears per stalk; from 4, one ear; and from 5 and 6 only .8 ears. Not only were there more ears from those plots with rows 18 inches apart, but they were equally as large and well filled. The silk formed on almost every plant for a second ear but with no results excepting in two instances.

A plot was also planted with the rows only one foot apart, and plants six inches apart in the row. This resulted in either no ears at all or a mere nubbin. The cut on the cover of the bulletin shows the twelve best ears out of the whole plot, only four of which approached edible size. The forcing-house runs nearly north and south, and the rows were made crosswise, or nearly east and west.

Training.—The only training thought necessary was to check the suckers which seem to start out very early in some of the varieties. These were easily pinched off or cut out, thus throwing the strength to the main stalk. We also found that it is unnecessary to allow all the tassels to remain on in order to secure sufficient pollen; one-half could easily be dispensed with. In so doing more strength would be thrown to the ear.

Pollinating.—Sweet corn grown under glass readily pollinates itself; the only thing necessary is that the atmosphere be

Digitized by Google

not too moist when the pollen is ripe. In this respect this crop is little care compared with many others which require usually considerable hand labor in order to set the fruit. In order to insure perfect pollination one can go over a house in a very short time by simply cutting a tassel here and there, and dusting the same upon the silk. It is doubtful, however, if this is needed.

Time to Maturity.—This will vary according to the variety as well as the temperature and general culture given. Of the three varieties under general test, all of which were planted under similar conditions on April 10, the first ear of edible size was from White Cob on July 1. Crosby's Early came next on July 4, and First of All at the same time, making for White Cob 83 days, and the other two 86 days, from seed. For general picking, however, July 6 was the first date, at which time about all the ears of each variety were ready, making 88 days. By keeping a high temperature and devoting a whole house to corn, it is believed that this crop could be harvested in a much shorter period. It usually takes from twelve to fifteen weeks to mature lettuce from seed. While of course corn requires more space in the house, it is readily seen that it can be grown with as quick results; also, were we able to produce two ears per plant, an ear of corn would represent the product from about the same space that a head of lettuce occupies.

Utilizing the Space Between the Rows.—While the corn is young, and until it is six weeks old, at which time it averages 21 inches in height, the space between the rows may be utilized with other so-called catch crops. After this time the corn begins to shade the ground and absorb the light necessary to plant growth. A number of different kinds of crops were planted between and in the rows in order to determine which could be grown to advantage with the corn. Those tested were radishes, lettuce, spinach, bush beans, dwarf tomatoes, and dwarf peas.

The radishes were very fine, and produced a crop fully equal to those grown in a bed by themselves. The varieties used were the Leafless and Rapid Forcing.

The open head Grand Rapids lettuce was found to be the best adapted for forcing with the corn, although the Boston

Digitized by Google

FIG. 6.—Concentration on small areas; various catch crops between the corn.

Digitized by Google

Market heading made a fine growth, and six weeks after transplanting started to head. The temperature was too high, however, for best results with this variety. The plants were set 8 x 8 inches, and covered the ground.

The spinach was ready to harvest on May 24, just 44 days from time of planting. This crop, however, does not make enough bulk to pay for growing, compared with either radishes or lettuce.

Bush beans, the seed of which was planted between the rows at the same time with the corn, were in bloom and 14 inches high on May 24, maturing for picking on June 15.

The Dwarf Aristocrat tomatoes were planted between rows of corn set three feet apart, and allowed to take their natural shape, pruning only to keep in bounds. On May 24 they were 20 inches tall and full of blossom. Considerable fruit set, but from lack of sunlight it failed to mature as early as it would have done under more favorable conditions.

The peas were also planted between the wider rows of corn. The variety used was Knott's Excelsior. They were of slow growth, and did not mature fruit until June 8. The yield was extremely light and far from profitable. The variety may have something to do with this.

The space may also be utilized for placing pots in starting melons, etc., for early transplanting out of doors.

Insects, Fungus, and Pests.—No insects seemed to bother the sweet corn when grown under glass. One stalk of corn developed smut, which was cut out before it matured. The worst trouble is liable to come from rats and mice. After they once get a taste of corn they persist in being troublesome until they are gotten rid of. Both dig out the corn when young, and the rats in a few cases attacked the growing corn.

VARIETIES

The varieties we have tested have been the Early Minnesota, Crosby's Early, White Cob, First of All, Early Fordhook, and Adams's Extra Early. All of these are grown to some extent in New England, and are popular generally. The Early Minnesota, Early Fordhook, and Adams's Extra Early were grown under less favorable conditions than the others. A specimen

Digitized by Google

of each variety is shown in Fig. 4, which represents their comparative heights and general appearance. The stalks grew taller, if anything, than they do in the garden in every case. The Adams's Extra Early was grown on account of its earliness regardless of its flavor. This variety is not a true sweet corn, but its merits are earliness and productiveness. The three varieties grown for the main crop, and upon which the data for this bulletin chiefly depend, are the Crosby's Early,

FIG. 7.—Radishes ready to pull between corn. (Bush Beans and younger radishes on the right).

White Cob, and First of All. A number of average ears of each of these is shown in Fig. 5.

No. 13, *Crosby's Early*.—This is a standard early white variety: average height under glass from 5 to 5½ feet. Good quality, and yielded at the rate of one ear to the stalk, all averaging as shown in Fig. 5; small cob; sends up numerous suckers. It ripens a few days later than any of the others but is very desirable for a market variety.

No. 14, *White Cob*.—In respect to height, yield, and general appearance, this variety was the same when grown in and

Digitized by Google

out of doors. One of the earliest; very dark green foliage, 5 feet high; numerous suckers; good-sized kernels, with small cob; good quality; many ears under size. Yield averaged almost one ear per stalk, running in size as shown in Fig. 5.

No. 15, *First of All.*—A new early to second early variety; ears good size and long; cob rather large; kernels medium sized; stalk averaged 5½ to 6 feet; quality fair. While one of the heaviest yielders out of doors, it fell behind in the greenhouse, producing at the rate of *eight-tenths* ears per stalk.

No. 26, *Early Fordhook.*—Not given a fair trial. Under more favorable circumstances we believe it would do well.

No. 10, *Early Minnesota.*—This variety was not as early as most of the others, taking a longer time than Crosby's Early.

From our experience with the above named varieties, I believe we can depend upon almost any variety that is desirable out of doors, to be equally valuable under glass. Moreover, if proper heat, moisture, and a rich soil be given, a crop will mature in the greenhouse in a shorter time than in the garden. In the forcing-house with the exception of light we can have almost ideal conditions. With the use of the electric light, even the cloudy weather of winter can be overcome to a degree.

For other varieties of sweet corn, we would ask the reader to consult BULLETIN No. 51. Two not in the test, which we believe are worthy of consideration for growing under glass are Early Beverly and Eastman's Early. Both were early and desirable in the garden.

If sweet corn proves to be a successful forcing-house crop, doubtless as with the muskmelon, tomatoes, cucumbers, etc., we can in a few years develop varieties that will be better adapted for this purpose than any of our present ones.

SUMMARY

1. Sweet corn should be included in the list of vegetables adapted for forcing under glass.

2. The requisites for forcing corn under glass are practically the same as those for forcing such plants as tomatoes, melons, cucumbers, egg-plants, etc.; a night temperature of not less than 60° to 70°, and ten degrees or more higher during day. Until pollen begins to fall the atmosphere of the house should be kept moist; the soil also should never become very dry.

Digitized by Google

3. The house adapted for forcing corn should have considerable space above the beds, ranging from 3½ to 8½ feet, according to the variety grown.

4. In order to be remunerative, the crop should be on the market before July, at which time the Southern product begins to arrive.

5. Any good, fertile greenhouse soil, containing plenty of available plant-food answers well for corn. Unlike many more delicate plants, when once established it is a ravenous feeder.

6. The extra early varieties mature in 83 days, while the standard early (Crosby) takes 86 days from seed.

7. When starting the plants in pots, precaution should be exercised, lest they become pot-bound. The 3-inch pots are good to start with, repotting into a 5- or 6-inch pot, and thence into the bed.

8. The stools or suckers should be pruned out, in order to throw the strength to one main stalk and its fruit. The tassels also may be thinned out, especially in spring fruiting, as there is an abundance of pollen produced at this time. For a winter crop it would probably not be advisable.

9. The varieties found to do very well were Crosby's Early, First of All, and White Cob. The White Cob was the earliest, but Crosby's Early was thought to be more desirable. Other varieties we believe well adapted to forcing are the following: Extra Early Beverly, Eastman's Early, and Early Fordhook. Varieties successfully grown in the garden seem to do equally well under glass.

10. An experiment for determining the proper distance to plant corn under glass, resulted in rows 18 inches apart, and 9 inches apart in the row.

11. During the early stages of growth a catch crop of radishes, Grand Rapids lettuce or other crops, can be taken off, or the space used for starting plants for transplanting into cold frames or the garden.

12. The only pests to contend with are rats and mice. Both persist in digging out the seed, and the rats attack the maturer corn, eating the more succulent parts and especially the ears. One of these rodents will do considerable damage in one night. Be sure to poison or destroy them before planting the crop.

Digitized by Google

Sci 1636.35

Bulletin 61 February, 1899

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE INSPECTION OF FERTILIZERS

IN 1898

IN CO-OPERATION WITH THE STATE BOARD OF AGRICULTURE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS. 1898

	Cents per pound.
Nitrogen in ammonia salts	14.
" nitrates	13.
" dry and fine ground fish, meat, and blood and in high grade mixed fertilizers	14.
Nitrogen in cotton-seed meal, linseed meal and castor-pomace	12.
Nitrogen in fine ground bone and tankage	13.5
" medium ground bone and tankage	11.
" coarse bone and tankage	8.
Phosphoric acid soluble in water	4.5
" " " ammonium citrate (reverted)	4.
" " in fine ground bone and tankage	4.
" " in medium ground bone and tankage	4.
" " in coarse bone and tankage	3.5
" " in fine ground fish, cotton-seed meal, linseed meal, castor-pomace, and wood-ashes	4.
" " insoluble in mixed fertilizers	2.
Potash as sulphate free from chlorides and in wood ashes	5.
" " muriate	4.25

The above values are based on the wholesale market price for the materials, when sold in large lots at the principal trade centers in New England. The valuation of a ton of any mixed fertilizer based on the above figures will usually fall ten dollars below the retail price at the local agency. This variation includes such fixed charges as cost of mixing, bags, cartage and freight, salaries and commissions of agents, and interest.

Digitized by Google

THE FERTILIZER INSPECTION IN 1898

This year, as in the past, the New Hampshire College Agricultural Experiment Station has coöperated with the State Board of Agriculture in an inspection of the commercial fertilizers sold in the state.

In accordance with the public statutes, the collection of samples of the different fertilizers has been in charge of the Secretary of the Board of Agriculture, Hon. N. J. Bachelder, who has been assisted by Mr. James A. Foord; while the chemical analyses have been performed under the direction of the chemist of the Experiment Station, Prof. Fred W. Morse, who has had for assistants, Messrs. Chas. D. Howard, Arthur Given, and Harry E. Barnard.

The work of the inspectors in this state cannot be finished before the farmers buy their season's stock of fertilizers, because the manufacturers do not, in many cases, place their goods in the hands of the local agents until April 1, or later. Consequently the analyses of the past year must serve as a guide to the composition of the fertilizers on the market for the coming year. The publication of this bulletin has therefore been delayed, with the idea that it will receive more attention now than if issued last fall, and thus be more effective in decreasing the use of inferior brands.

Under the present fertilizer law, a manufacturer pays a license fee, which permits the sale of as many different brands of fertilizers as he may choose to place on the market. The multiplication of brands by the different makers has required more analyses than could be paid for out of the license fees, therefore this year one-third of the samples collected were not analyzed. The brands included in this lot had been examined for two successive years, 1896 and 1897, and found to be equal to their respective guarantees in all respects.

The list is published in order that all brands found by the

Digitized by Google

agent of the Board of Agriculture may be included in this report, and that their guarantees may be compared by those farmers who may wish to select a fertilizer on the basis of its percentage composition.

LIST OF TOWNS VISITED BY THE AGENT OF THE BOARD OF AGRICULTURE

Newton	Rockingham County
Exeter	" "
Portsmouth	" "
Kingston	" "
Candia Village	" "
Auburn	" "
Silver Lake	Carroll "
Farmington	Strafford "
Dover	" "
Gilmanton Iron Works	Belknap "
Laconia	" "
Lakeport	" "
Tilton	" "
Pittsfield	Merrimack "
Bradford	" "
Concord	" "
Manchester	Hillsborough "
New Boston	" "
Mont Vernon	" "
Greenville	" "
Nashua	" "
Troy	Cheshire "
Keene	" "
Newport	Sullivan "
Cornish Centre	" "
Cornish Flat	" "
Canaan	Grafton "
West Canaan	" "
Canaan Center	" "
Hanover	" "
Littleton	" "
South Littleton	" "
Colebrook	Coös "
West Stewartstown	" "

Digitized by Google

LIST OF MANUFACTURERS

Armour Fertilizer Works.
Bowker Fertilizer Co.
Bradley Fertilizer Co.
Baugh & Sons Co.
Clark's Cove Fertilizer Co.
Cumberland Bone Phosphate Co.
Cleveland Dryer Co.
Crocker Fertilizer and Chemical Co.
L. B. Darling Fertilizer Co.
E. Frank Coe Fertilizer Co.
Great Eastern Fertilizer Co.
Lister's Agricultural Chemical Works.
Lavery Fertilizing Co.
Lowell Fertilizer Co.
Manchester Slaughtering and Rendering Co.
Packers' Union Fertilizer Co.
Pacific Guano Co.
Parmenter & Polsey Fertilizer Co.
Quinnipiac Company.
Read Fertilizer Co.
Russian Cement Co.
Henry F. Tucker Co.
Standard Fertilizer Co.
Williams & Clark Fertilizer Co.

Digitized by Google

COMPOSITION OF MIXED FERTILIZERS COLLECTED BY THE STATE BOARD OF AGRICULTURE, 1898.

Number.	Manufacturer and Brand.	Nitrogen in 100 Lbs.		Phosphoric Acid in 100 Lbs.							Potash in 100 Lbs.	
							Total.		Available.			
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Baugh & Sons Co.											
1	Baugh's General Crop Grower	1.12	.82	5.68	3.27	1.15	10.10	.....	8.95	8.00	1.49	1.00
2	Baugh's Special Potato Manure	1.67	1.65	4.72	1.83	1.84	8.39	7.50	6.55	5.00	9.53	10.00
3	Economical Fertilizer	2.10	1.65	5.05	3.17	3.34	11.56	.....	8.22	7.00	2.28	2.00
4	Twenty-five Dollar Phosphate	2.35	2.06	5.69	3.50	2.71	11.90	.....	9.19	7.00	0.90	.50
	Bowker Fertilizer Co.											
5	Bowker's Bone, Blood, and Potash	3.92	4.00	3.56	4.29	4.15	12.00	12.00	7.85	8.00	7.41	7.00
6	Granite State Fertilizer	1.88	1.00	4.57	2.66	3.66	10.89	10.00	7.23	7.00	7.03	6.00
7	Bowker's Potato and Vegetable Phosphate	1.61	1.50	5.87	2.42	2.94	11.23	10.00	8.29	8.00	2.32	2.00
8	Stockbridge Manure for Corn, Grain, and Fodder Corn	3.08	3.00	5.63	2.44	2.96	11.03	10.00	8.07	7.00	7.81	7.00
9	Bowker's Special Fertilizer for Potatoes and Vegetables	2.24	2.25	6.72	2.47	1.34	10.53	10.00	9.19	8.00	4.63	4.00
60	Bowker's Hill and Drill Phosphate	2.15	2.25	6.63	2.54	3.48	12.65	12.00	9.17	9.00	2.57	2.00
	Bradley Fertilizer Co.											
10	Bradley's Eclipse Phosphate	1.65	1.00	5.63	3.63	3.10	12.36	12.00	9.26	10.00	1.77	1.50
11	Bradley's Grass Manure for Top-dressing	4.04	3.91	4.03	1.20	1.06	6.51	6.00	5.23	5.00	2.50	2.00
12	Bradley's Seeding-down Manure	2.52	2.50	6.59	3.44	1.97	12.00	12.00	10.03	7.00	2.26	2.00
13	Original Coe's Superphosphate	2.13	2.00	5.44	3.56	2.76	11.78	10.00	8.97	8.00	1.78	1.00
14	English Lawn Fertilizer	4.50	4.00	2.94	3.62	1.64	8.20	6.00	6.56	5.00	3.26	2.50

Digitized by Google

15	Bradley's Complete Manure for Potatoes and Vegetables	3.50	3.30	3.45	4.69	2 99	11.13	9.00	8.14	8.00	7.17	7.00
16	Bradley's Complete Manure for Corn and Grain	3.37	3.30	5.31	6.13	2.40	13.84	13.00	11.44	12 00	3.15	3.00
	CLARK'S COVE FERTILIZER CO.											
17	King Philip Alkaline Guano	1.12	1.00	6.10	3.96	1.80	11.86	9.00	10.06	8.00	2.60	2.00
	CLEVELAND DRYER CO.											
18	Cleveland Superphosphate	2.14	2.05	5.88	3.86	2.78	12.02	11.00	9.24	9.00	2.01	2.00
	L. B. DARLING FERTILIZER CO.											
19	Darling's New Hampshire Special	3.59	3.00	4.52	4.57	0.92	10.01	10.00	9.09	8.00	8.45	8 00
20	Darling's Special L. I. C. Brand	4.20	4.12	2.70	2.71	3.84	9.25	8.00	5.41	7.00	10.15	10.00
	E. FRANK COE CO.											
21	E. Frank Coe's Prize Brand Grain and Grass Fertilizer	0.56	.40	6.52	4.18	3.96	14.66	12.00	10.70	10.50	1.85	1.25
22	E. Frank Coe's Celebrated Special Potato Fertilizer	1.62	1.65	6.40	2.19	2.94	11.53	10.00	8.59	8.00	4.15	4.00
23	E. Frank Coe's Columbian Bone Superphosphate	1.49	1.20	7.42	2.45	3.12	12.99	11.00	9 87	9.00	2.45	1.85
	GREAT EASTERN FERTILIZER CO.											
24	Great Eastern Northern Corn Special	3.13	2.88	0.77	7.20	1.87	9.84	9.00	7.97	8.00	2.80	2.00
25	Great Eastern General Fertilizer	1.07	.82	0.64	7.19	1.85	9.68	9.00	7.83	8.00	4.95	4.00
	LAVERY FERTILIZER CO.											
26	Lavery Fertilizer Co. Superphosphate	2.45	1.95	1.54	8.60	1.12	11.26	.....	10.14	10.00	0.56	2.35
	LOWELL FERTILIZER CO.											
27	Swift's Lowell Potato Phosphate	2.75	2.47	6.09	1.80	1.83	9.72	9.00	7.89	8.00	6.33	6.00
28	Swift's Lowell Bone Fertilizer for Corn and Grain	1.84	1.65	6.17	1.89	1.82	9.88	9.00	8.06	8.00	3.30	3.00
29	Swift's Lowell Fruit and Vine for Strawberries.	3.54	3.29	6.71	2.69	1.26	10.66	9.00	9.40	8.00	5.58	6.00

Digitized by Google

COMPOSITION OF FERTILIZERS COLLECTED BY THE STATE BOARD OF AGRICULTURE, 1898.—*Continued.*

Number.	Manufacturer and Brand.	Nitrogen in 100 Lbs.		Phosphoric Acid in 100 Lbs.							Potosh in 100 Lbs.	
							Total.		Available.			
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Lowell Fertilizer Co.—*Continued.*											
30	Swift's Lowell Garden Manure	3.70	4.10	5.50	1.75	1.70	8.95	8.00	7.25	7.00	5.55	5.00
31	Swift's Lowell Animal Brand for General Use	2.53	2.46	7.67	1.48	2.06	11.21	10.00	9.15	9.00	5.72	4.00
32	Swift's Lowell Ground Bone	1.97	2.47	.....	10.40	18.80	29.20	23.00	10.40	.....	.....	.....
59	Swift's Lowell Dissolved Bone and Potash	1.85	1.65	5.53	4.10	2.10	11.73	10.00	9.63	9.00	2.61	2.00
33	Swift's Lowell Lawn Dressing	3.29	4.11	5.47	3.41	2.64	11.55	8.00	8.91	7.00	5.93	5.00
	Manchester Slaughtering and Rendering Co.											
34	Tankage	5.00	.....	.....	6.07	12.57	18.64	.....	6.07	.....	.....	.....
	Parker's Union Fertilizer Co.											
35	High Grade Wheat, Oats, and Clover Fertilizer	.....	.....	6.39	6.29	2.80	14.98	.....	12.68	11.00	1.94	2.00
36	High Grade Gardner's Complete Manure	2.59	2.47	6.00	3.55	1.30	10.85	10.00	9.55	8.00	8.65	10.00
	Pacific Guano Co.											
37	Potato Special	1.95	2.06	4.36	4.52	2.34	11.22	9.00	8.88	8.00	3.30	3.00
	Parmenter and Polsey Fertilizer Co.											
38	Dissolved Bone	1.60	1.65	2.29	14.18	4.80	21.27	20.00	16.47	15.00	.....	.....

Digitized by Google

39	Muriate of Potash									50.38	50.00
65	Plymouth Rock Brand Fertilizer	2.89	2.47	2.54	6.17	2.32	11.03	9.00	8.71	8.00	4.18	4.00
	READ FERTILIZER CO.										
40	High Grade Farmer's Friend	3.18	3.25	3.63	1.05	2.50	7.18	6.00	4.68	5.00	10.63	10.00
41	Sure Catch Fertilizer			2.95	4.59	0.64	8.18	7.00	7.54	6.00	4.23	4.00
42	Farmer's Friend Superphosphate	2.26	2.00	7.54	2.07	2.06	11.67	10.00	9.61	9.00	2.65	2.00
43	Samson's Fertilizer for Potatoes	1.86	1.65	4.27	2.07	1.78	8.12	7.00	6.34	6.00	4.74	4.00
44	Original Alkaline Bone			4.67	5.21	1.37	11.25	11.00	9.88	10.00	2.35	3.00
	RUSSIAN CEMENT CO.										
45	Essex XXX Fish and Potash	2.62	2.10	5.17	3.70	5.27	14.14	12.00	8.87	10.00	2.39	2.25
46	Essex Complete Manure for Corn, Grain, and Grass	4.04	3.70	4.93	2.09	4.25	11.27	9.50	7.02	7.00	10.02	9.50
47	Essex Complete Manure for Potatoes, Roots, and Vegetables	3.72	3.70	5.36	2.25	4.06	11.67	9.00	7.61	7.00	9.29	8.50
	HENRY F. TUCKER CO.										
48	Imperial Bone Superphosphate	1.17	1.25	6.16	1.90	2.12	10.18	11.00	8.06	9.00	2.47	1.85
49	Tucker's Special Potato Fertilizer	2.05	2.06	2.37	3.20	4.05	9.62	9.00	5.57	8.00	5.70	6.00
50	Tucker's Grass Manure	5.21	3.91	4.45	0.85	2.60	7.90	6.00	5.30	5.00	2.90	2.00
	STANDARD FERTILIZER CO.										
51	Standard Special for Potatoes	2.06	2.05	5.96	2.07	2.94	10.97	9.00	8.03	8.00	3.34	3.00
	WILLIAMS & CLARK FERTILIZER CO.										
52	Americus Corn Phosophate	2.10	2.06	5.25	3.89	3.24	12.38	10.00	9.14	9.00	1.94	1.50
53	Americus Potato Manure	2.06	2.06	5.90	2.66	3.32	11.88	9.00	8.56	8.00	3.14	3.00
54	Prolific Crop Producer	1.12	.82	3.83	2.06	4.54	10.43	7.00	5.89	6.00	1.47	1.00
	ARMOUR FERTILIZER WORKS.										
55	Armour's All Soluble	3.02	2.88	4.85	2.72	3.05	10.62	10.00	7.57	8.00	5.98	4.00
56	Armour's Ammoniated Bone with Potash	3.55	2.47	4.56	1.67	6.21	12.44	8.00	6.23	6.00	2.77	2.00
57	Armour's Grain Grower	2.94	1.64	5.80	2.15	4.91	12.86	10.00	7.95	8.00	2.66	2.00

Digitized by Google

COMPOSITION OF FERTILIZERS COLLECTED BY THE STATE BOARD OF AGRICULTURE, 1898.—*Continued.*

Number.	Manufacturer and Brand.	Nitrogen in 100 Lbs.		Phosphoric Acid in 100 Lbs.							Potash in 100 Lbs.	
							Total.		Available.			
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Crocker Fertilizer and Chemical Co.											
61	Crocker's Potato, Hop, and Tobacco Phosphate.	2.12	2.00	8.20	1.73	1.22	11.15	11.00	9 93	10.00	4.07	3.25
	Lister's Agricultural Chemical Works.											
62	Lister's Special Potato Fertilizer.....	1.77	1.65	6.87	1.54	2.72	11.13	9.00	8.41	8.00	3.28	3.00
	Quinnipiac Co.											
63	Quinnipiac Potato Phosphate.....	2.54	2.05	7.00	1 93	3.03	11.96	9.00	8.93	8.00	3.21	3.00
	Cumberland Bone Phosphate Co.											
64	Cumberland Potato Fertilizer.....	1.92	2.06	6.57	2.46	3.22	12.25	11.00	9.03	9.00	2.95	3.00

Digitized by Google

BRANDS OF FERTILIZERS SAMPLED BUT NOT ANALYZED.

Manufacturer and Brand.	Guarantee in 100 Lbs.			
		Phosphoric Acid.		
	Nitrogen.	Total.	Available.	Potash.
Bowker Fertilizer Co.				
Bowker's Square Brand Bone and Potash	1.50	12.00	6.00	2.00
Stockbridge Manure for Top-dressing	4.75	6.00	4.00	6.00
Stockbridge Manure for Potatoes and Vegetables	3.20	7 00	5.00	10.00
Bradley Fertilizer Co.				
Bradley's XL Superphosphate	2.50	11.00	9.00	2.00
Bradley's Corn Phosphate	2.06	10.00	9.00	1.50
Bradley's Potato Manure	2.50	8.00	6.00	5.00
Clark's Cove Fertilizer Co.				
Clark's Cove Potato Fertilizer	2.00	9.00	8.00	3.00
Cleveland Dryer Co.				
Cleveland Potato Phosphate	2.05	10.00	8.00	3.00
Crocker Fertilizer and Chemical Co.				
Crocker's New Rival Ammoniated Superphosphate	1.23	11.00	10.00	1.60
Crocker's Ammoniated Corn Phosphate	2.00	11.00	10.00	1.60
L. B. Darling Fertilizer Co.				
Darling's Potato and Root Crop Manure	2.88	10.00	9.00	7.00
Darling's Animal Fertiltzer	3.30	10.00	6.00	4.00
E. Frank Coe Co.				
E. Frank Coe's High Grade Ammoniated Bone Superphosphate	2.00	11.00	9.00	1.85
E. Frank Coe's Columbian Corn Fertilizer	1.00	11.00	9.00	1.85
E. Frank Coe's Columbian Potato Fertilizer	1.20	11.00	9.00	1.85
E. Frank Coe's Celebrated Special Grass and Grain Fertilizer	.80	10.00	9.00	1.35
Great Eastern Fertilizer Co.				
Great Eastern Grass and Oats Fertilizer		12.00	11.00	2.00
Great Eastern Potato Manure	2.06	9.00	8.00	4.00
Lister's Agricultural and Chemical Works.				
Lister's Success Fertilizer	1.24	11.50	9.50	2.00
Packers' Union Fertilizer Co.				
Packers' Union Animal Corn Fertilizer	2.47	9.00	8.00	2.00
Packers' Union High Grade Universal Fertilizer	.82	9.00	8.00	5.00

Digitized by Google

BRANDS OF FERTILIZERS SAMPLED BUT NOT ANALYZED.

Manufacturer and Brand.	Guarantee in 100 Lbs.			
		Phosphoric Acid.		
	Nitrogen.	Total.	Available.	Potash.
Pacific Guano Co.				
Soluble Pacific Guano	2.25	10.50	8.50	2.00
Quinnipiac Co.				
Quinnipiac Corn Manure	2.06	10.00	9.00	1.50
Quinnipiac Climax Phosphate	1.03	9.00	8.00	2.00
Read Fertilizer Co.				
Read's Standard Superphosphate	.83	9.00	8.00	4.00
Read's Practical Potato Special	.83	5.00	4.00	8.00
Read's Vegetable and Vine	1.65	7.00	6.00	8.00
Read's Fish, Bone, and Potash	2.50	5.00	4.00	4.00
Read's Leader Guano	.83	8.00	7.00	2.00
Henry F. Tucker Co.				
Tucker's Original Bay State	2.06	11.00	9.00	2.00
Standard Fertilizer Co.				
Standard Fertilizer	2.00	10.00	8.00	2.00

FRED W. MORSE,
Chemist.

Digitized by Google

Sci 1636.35

Bulletin 62 February, 1899

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

FORCING
POLE BEANS UNDER GLASS

NESMYTH HALL, EXPERIMENT STATION BUILDING.

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

FIG. 8.—Pole beans running on ordinary bean poles in greenhouse.

Digitized by Google

FORCING POLE BEANS UNDER GLASS

BY FRANK WM. RANE

The forcing of dwarf or bush beans under glass has been a favorite practice at certain seasons of the year with most gardeners. The forcing of the pole or running varieties, I have reason to believe, has never heretofore received attention.

During the winter season of 1896-'97 a first trial was made which proved fairly successful with one variety. The following season, 1897-'98, two more crops were grown, both of which proved very interesting and I believe of sufficient value to merit attention.

The pole bean, like cucumbers, tomatoes trained to one stem, sweet corn, etc., must have plenty of headroom or space above the bench or bed in which to develop. Doubtless this accounts for its not having been considered before. The modern lettuce and cucumber house with the beds directly on the ground are well adapted for this crop. The house described for sweet corn in Bulletin 60 of this station, of which a cut is also given, is well suited to force pole beans.

The soil should be well enriched, containing an abundance of available plant food. That used by us was a sandy loam composted by mixing equal parts of rich dark loam, sand, and manure. The beds were directly upon the ground and the prepared soil averaged about seven inches in depth. The subsoil was loosened up to about an equal depth before the other was put in, thus giving a seed bed of fairly good mechanical condition.

Sowing and Transplanting. By soaking the seed much time is gained on account of its earlier germination. It is usually an advantage also to start the seed in flower pots and from here to transplant into the permanent beds; in so doing the previous crop can be given more time and as space in a

Digitized by Google

forcing house is valuable, more is realized financially. The plants should not be allowed to become root-bound before transplanting, as the check or set back thus given materially lessens all chances for a crop.

The pole bean germinates so readily and begins to run in so short a time, if under favorable conditions, that we have not deemed it advisable to shift or transplant but once. We therefore start them in four- or six-inch pots, according to the length of time they are to remain in the same, and from these transplant directly into the beds. The time usually saved by so doing is from two weeks to a month, depending upon conditions; it usually takes from five to twelve days for the seed to germinate to begin with. Only plants that have made a healthy growth from the first are likely to give satisfactory results.

Training. Pole beans must have some kind of a support and this once arranged for they will take care of themselves. We have tried two methods,—one, the use of ordinary bean poles commonly resorted to out of doors, as is shown in Fig. 8; and for the other, wires were run along parallel with and directly over, the rows of beans at the proper height, which in our case was seven feet. Then a wooden peg with a notch cut near the top was driven in the bed at each hill, and to these pegs a string was fastened, running it over the wire at the top and down again, as is shown in Fig. 9. The advantage of the string over the pole is less shade and hence better results; also the overhead space is utilized to better advantage.

Pollination. The bean looks out for itself, happily for the grower; they are to all appearances self-fertile.

Varieties. Comparatively few varities have been tested, as our aim was not so much for this purpose as to study them as a class. The varieties of pole beans grown were, Lazy Wife, Mastiff Golden Pod, Golden Champion, Early Golden Cluster, and one variety of pole Lima beans, Seibert's Early. All of these have been grown in the garden and are fairly well-known.

1. Lazy Wife (Burpee). A dark green pod of medium size, —4 to 6 inches in length. It was about five days later than the other varieties in maturing and not so prolific.

Digitized by Google

3. Mastiff Golden Pod (Gregory, Novelty 1896). A wax bean, strong grower, good-sized pods, and a heavy yielder. While this variety is not the earliest to fruit, it continues to yield a large and profitable crop for a long period. Not only is this true but it out-yielded the others in the first fourteen days of bearing, representing the first three pickings.

4. Golden Champion (Coles). A wax variety, strong grower, large pods averaging 6½ inches in length. A good

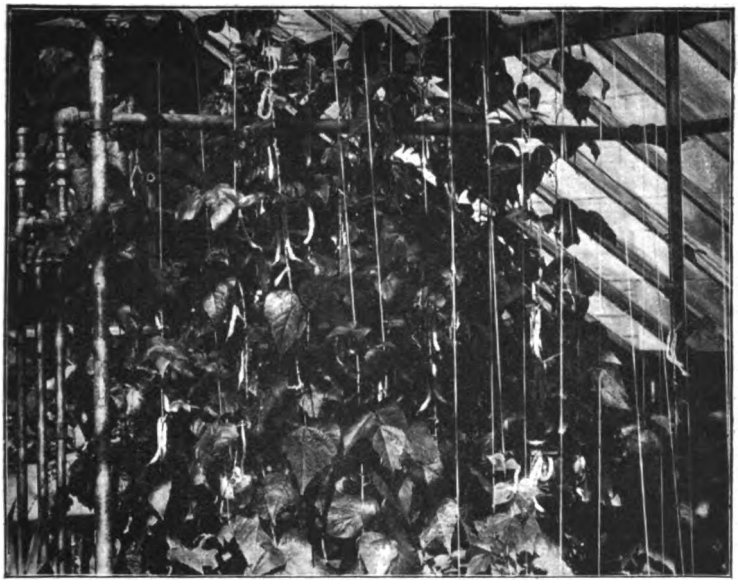


FIG. 9.—Pole beans running upon string trellis.

variety for forcing. It was early and yielded well for an average number of pickings, but later was affected with rot. The vines also did not last as long as numbers 3 and 17.

17. Early Golden Cluster (Gregory). This is a very long, waxy white bean. Vines healthy and vigorous; it was second in productiveness. Like No. 3 it continued in bearing throughout an equally long period and remained very healthy.

Seibert's Early Pole Lima Bean was also forced at the same time, and although it proved very productive and was easily

Digitized by Google

forced, it required 102 days to mature from time of germination. The fruit ripened all at once and the yield averaged 1 lb., 13 oz., per hill.

In order to compare these with various dwarf or bush beans from point of yield, the following varieties were grown under similar conditions,—Stringless Green Pod, Early Red Valentine, Marvel of Paris, Dwarf Lyonnaice, Extra Early Refugee and Improved Red Valentine,—all green pod varieties;—with Davis Kidney, Horticultural Wax, and Golden Wax of the wax varieties. The results have been tabulated in order that ready comparisons may be made. The number of plants considered in each instance is one hundred. The number of days given in the table is from time of germination until fruiting. The fruiting period has been divided into three parts in order to show in which the variety is most productive.

Number.	Variety.	No. Days Germ. to First Picking.	Weight.			Total Weight per 100 Plants.
			First Three Pickings.	Fourth and Fifth Pickings.	Sixth, Seventh, and Eighth Pickings.	
	A. Dwarf Green Pod.		oz.	oz.	oz.	oz.
1	Stringless Green Pod	55	140	170		310
3	Early Red Valentine	55	148	71		219
6	Marvel of Paris	55	148	13		161
7	Improved Red Valentine	55	140	100		240
8	Dwarf Lyonnaice	55	40	31		71
19	Extra Early Refugee	55	246	140		386
	B. Dwarf Wax.					
6	Davis Kidney	55	444	34		478
10	Horticultural Wax	55	213	57		270
11	Golden Wax	55	336	48		384
	D. Pole Lima.					
1	Seibert's Early	102	950			950
	E. Pole Beans.					
1	Lazy Wife	86	320			320
3	Mastiff Golden Pod (Apr.)	54	798	636	978	2452
3	" " " (Jan.)	57	560	208	240	1008
4	Golden Champion (Mar.)	62	197	230		427
4	" " (Jan.)	57	405	135	50	590
4	" " (Apr.)	54	590	150	150	890
17	Early Golden Cluster	54	627	387	433	1447

Digitized by Google

From the above table it is evident that the pole beans are much more productive than the dwarf varieties. Not only is this true in the first three pickings, but they continue to yield good returns for a much longer period. The time from germination to maturity is a trifle longer perhaps with pole beans than with the dwarf varieties.

It may be said, however, that the above-named dwarf varieties are not those commonly forced excepting perhaps the Extra Early Refugee; this is likewise true of the pole varieties. Doubtless should the pole bean receive attention, a variety could be developed in a comparatively short time that would be equally as well adapted for forcing as the popular Sion House variety of the dwarf beans.

Distance to Plant. The first trial was made by planting the beans in rows eighteen inches apart each way, using two or three plants in each hill. This resulted in a very dense foliage when fully grown but it did not seem to hinder their productivity.

Toward the latter part of the experiment one variety was touched with bean rot but the others were perfectly healthy. The other trial was made by planting the hills similarly but by using cords for each plant to run on instead of poles as in the former case. The plants were more evenly distributed above the bench and gave better results. Pole beans are usually planted three or four feet apart out of doors.

Catch crops, like radishes, which come off quickly, can be planted between pole beans during their earlier stages.

Insects, Fungus, and Pests. No pests of any kind seemed to trouble us excepting the single instance of pod rot which cut short the late picking of the Golden Champion variety during one of the trials. Red spider and mite are said to be troublesome in forcing dwarf beans, and these are kept in check by maintaining a moist atmosphere.

Marketing. In the East string beans are usually sold by the quart measure during season, but the forced product is generally sold by the bunch, tying up from 25 to 50 pods together, according to the size of the variety. The price varies according to the demand; it is thought that from 25 to 50 cents a bunch may be considered an average price. If dwarf beans

Digitized by Google

have been made a success, surely the best pole varieties, being more productive, cannot help from becoming a profitable crop under similar conditions.

SUMMARY.

1. Pole beans should be included in the list of vegetables adapted for forcing under glass.

2. The requisites for forcing pole beans under glass are practically the same as for bush beans, sweet corn, melons, cucumbers, etc.; a night temperature of not less than 60° with 10° or more higher during the day. The house should be kept moist, and the soil likewise should never become very dry.

3. The house adapted for forcing pole beans should have considerable space above the beds, ranging about eight feet.

4. Pole beans thrive well in almost any good fertile greenhouse soil. In this respect they resemble corn.

5. The time from germination until maturity varies with different varieties. The range for those tested was from 54 to 62 days.

6. Much time is saved by starting the seed in pots, precaution being taken not to allow the plant to become pot bound before transplanting. The plants should be in their permanent positions before they begin to run.

7. The varieties that were found to do well when tested were Mastiff Golden Pod, Early Golden Cluster and Golden Champion, named in order of productiveness.

8. A cord trellis is preferable to the ordinary bean pole for training up the plants. They are more evenly distributed by the use of the cord and, too, the shade from the pole is avoided.

9. Practically no trouble from insects or fungus attended the growing of this crop. One variety developed a slight tendency to pod rot at the last picking. Red spider and mite, which have been reported as troublesome in forcing dwarf beans, are kept in check by maintaining a moist atmosphere.

10. Where bush beans can be made a success as a main crop, with a house adapted for them, pole beans we believe, will be found much more productive, area for area, and hence more profitable.

Digitized by Google

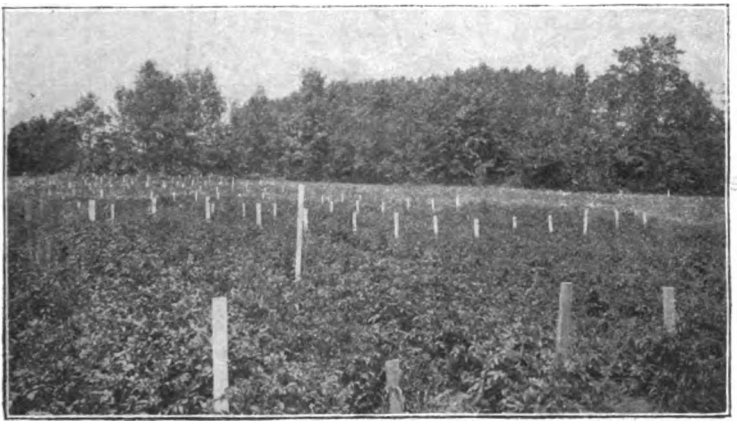
Sci 1636.35

Bulletin 63 March, 1899

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THIRD POTATO REPORT



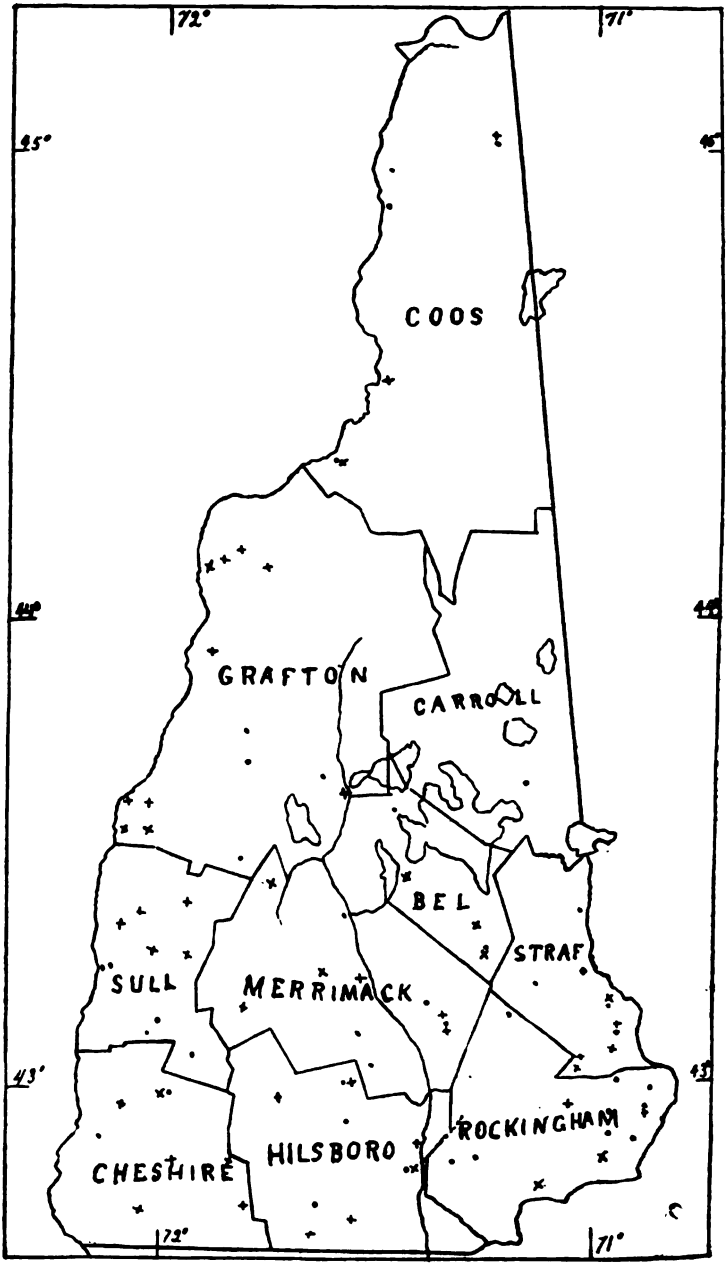
Experiment Station Potato Field.

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY



Map showing points in the state where Potato experiments are being conducted.

Digitized by Google

THIRD POTATO REPORT

BY FRANK WM. RANE

The potato is an important crop in New Hampshire and in the interest of potato-growers this bulletin is issued. For the past three years a long list of varieties has been grown here at the college, the first two years having been reported upon in Bulletin 41, "Potatoes," and Bulletin 48, "Ninth Annual Report." The present report, therefore, covers the results with those varieties used in the two previous seasons together with the new introductions, and as well the results of various potato growers throughout the state, who have coöperated with the Experiment Station.

It will be remembered that when Bulletin 41 was published, we made the following offer:

"After we have selected a sufficient quantity for seed purposes, we shall be pleased to send, at the expense of the receiver, a limited quantity (a few potatoes) for test purposes, provided the person receiving them has had experience in potato growing, and will report his results as soon as the crop is harvested."

In response a very long list of applications was received from all sections of the state. They were complied with as far as the seed went and we were able to send in this way to over two hundred persons. The season of '97 proved to be wet and unfavorable and as a result comparatively few growers reported. Last spring we desired to repeat the work, and in order to ensure a reply, only those who had taken sufficient interest to respond the previous year, were included in the list. While the season was not an ideal one for potato-growing, it was not nearly so discouraging as that of the previous year. The rot was especially troublesome. In most sections a fair yield was secured, but in Coös county, a grand potato section, the crop was far below the usual yield.

Digitized by Google

The three years of experience with potato-growing here at the college, together with the reports from others throughout the state, warrant us in feeling that the data herein given represent and stand for the conditions of our state.

Following the results at the Experiment Station come the reports from the farmers, which for convenience in comparison, have been separated into counties. In comparing the various counties it will be readily seen that some are far ahead of others as potato sections; also even in the same county some seem to be able to grow good crops, while the average yield may be low. It is also evident that the returns per acre are greater in the northern than in the southern part of the state. Why is this? Some will say that their natural conditions are better; but the question might be raised, Why do a few in the southern part get equally good results? These are questions worthy of thought. The northern part of the state is farther from markets and the fact that it is necessary to raise more potatoes in order to get equal returns from area planted, may be one reason. A higher degree of cultivation and better systems of rotation are also thought to exist in general farming in the northern part of the state.

POTATOES IN COÖS COUNTY

The writer was greatly surprised to see the wonderful potato industry in Coös county, especially about Colebrook. It is not uncommon to see processions of wagons heavily laden with the finest of potatoes on their way to market throughout the potato season. A very enthusiastic young farmer, who is also a graduate from the agricultural course of the college, Mr. Burton A. Corbett, B. S., located at Colebrook, was asked to write a short sketch of potato growing, as practised in his section, which we believe will be of interest. It is as follows:

"In potato production Coös county is to this state what Aroostook county is to the state of Maine. From the very first potatoes have been one of the leading crops. Formerly nearly the whole crop was worked up into starch, there having been six starch factories in the town of Colebrook alone. At present nearly all the marketable potatoes are sold to local dealers, who ship them, for the most part, to the larger towns and cities of southern New England. The starch factories get but very few except the culls.

Digitized by Google

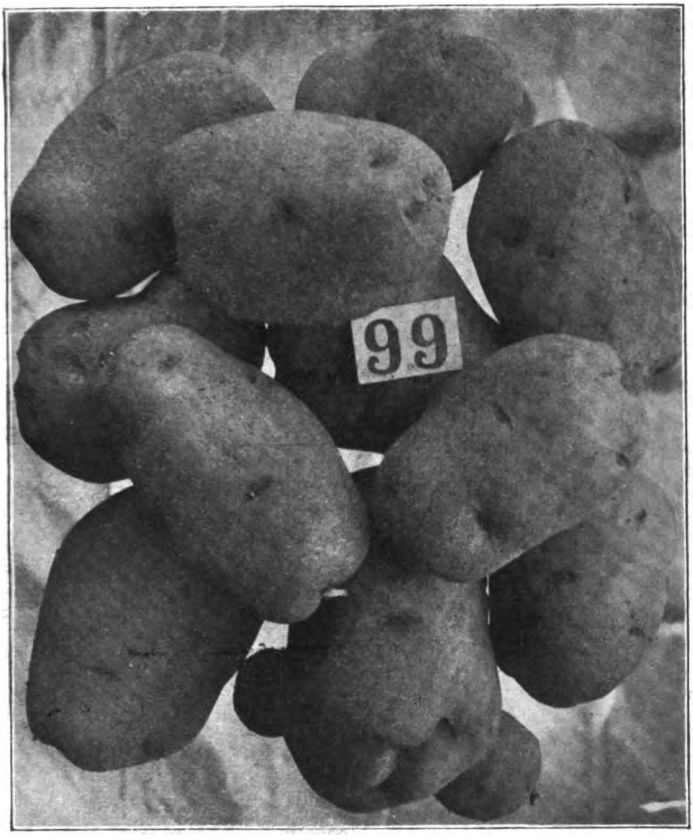


FIG. 11. Red American Wonder.

Digitized by Google

"In this section the potato is generally planted on sod land that was broken during the fall or summer of the previous season and given a liberal dressing of stable manure. By some the manure is turned under, and by others it is applied on the furrows and harrowed in. Both methods have stanch advocates.

"Hill culture is used altogether. The rows are placed from two and one-half to three feet apart, with the hills from twelve to twenty inches apart in the row. From ten to twenty bushels of seed are used per acre,—fifteen or eighteen bushels being the quantity used by most growers. Most of the farmers use commercial fertilizers, at the rate of from three to four hundred pounds per acre in the hill. This is thought to be profitable, as it gives the plants a good start. Both the seed and the phosphate are dropped by hand, and then covered with a two-horse hoe, with the wings adjusted for that purpose.

"Soon after the plants appear above ground they are hoed, the earth being thrown up around them with the horse hoe, which is followed by the hand hoe, to uncover any that chance to be covered and to cut or pull out stray weeds. About two weeks later the second and last hoeing is given. This time the drills are made as large as possible with the horse hoe. At this hoeing but little hand-work is done unless the piece is very tough or weedy.

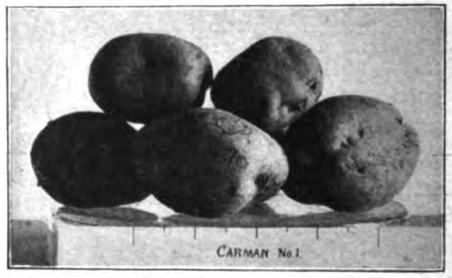


FIG. 12. Carman No. 1 (10).

"After this nothing is usually done, except to apply Paris green once or twice in case the beetles threaten to injure the vines. A very few farmers use Bordeaux mixture for the blight. Some of the more painstaking pull or cut out any weeds that may appear among the vines in August, before their seeds ripen.

"The crop is dug by hand, the tined digger being the favorite implement. The average yield is about two hundred and fifty bushels per acre in good seasons. In extra good seasons entire fields sometimes yield as high as four hundred bushels per acre, and five hundred bushels are occasionally grown.

"The past season was a rather poor one for the potato-grower, as the yield was small and many varieties rotted badly. The Adirondack, which gave excellent results in 1897 and was consequently largely planted in 1898, rotted very badly and the yield was not large. The average yield of all varieties in this section was probably not more than one hundred and fifty, or, at most, two hundred bushels per acre. The varieties giving best satisfaction the past season were: Dakota Red, American Wonder (red), and Delaware or Green Mountain."

Digitized by Google

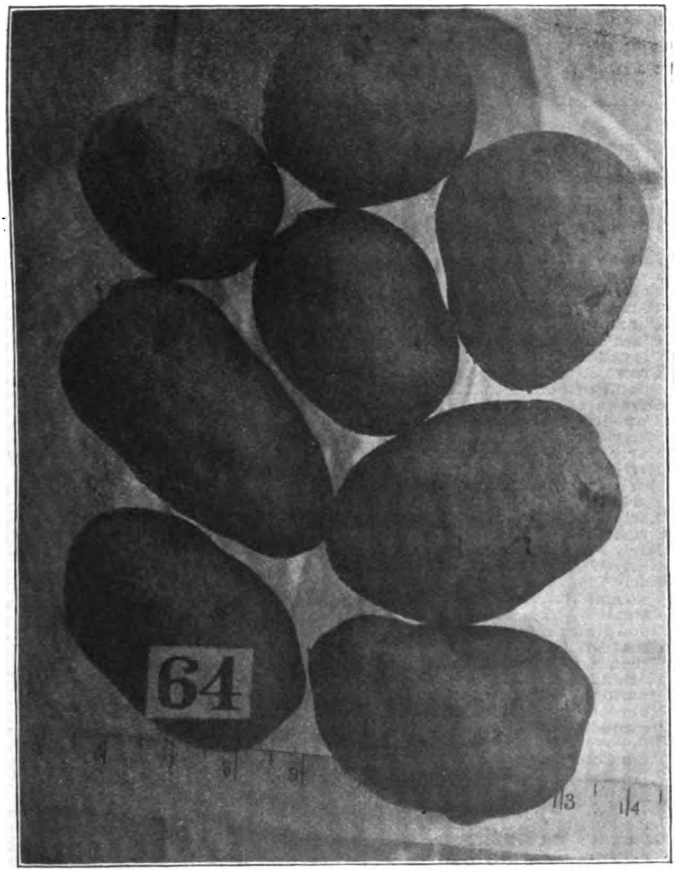


FIG. 13. Seneca Beauty.

Digitized by Google

TABLE I.—Comparison of Varieties of Potatoes, Season of 1896. (Yield Per Acre Calculated from Thirty-two Feet of Row. All Under Similar Conditions.)

Number.	Variety.	Form of Top.	Yield. Large.	Yield. Small.	Yield. Per acre.	Color of skin. W, white; R, red; Y, yellow.	Per ct. of rot.
			Lbs.	Lbs.	Bush.		
1	Uncle Sam	Medium	23¼	4½	265.1	W.	1
2	American Wonder	Large	33¼	8	334.4	"	4
3	Banner	Small	20	2¼	182.4	"	2
4	Blush	Large	37¾	4¼	340.6	"	
5	Brownell's Winner	Medium	28¾	5	273.2	"	
6	Burpee's Extra Early	"	27¼	5½	265.1	R.	1
7	Burpee's Superior	Large	18	3¾	176	W.	
8	Bill Nye	Medium	23¾	6¼	245.2	Y.	1
9	Bracy's Rising Sun	Large	22¾	7	240.8	R.	1
10	Carman No. 1	"	32½	4	293.9	W.	1
11	Carman No. 3	Medium	30	3	267.5	W.	1
12	Champion	Small	16	5	170.2	Y.	1
13	Clark's No. 1	Very l'ge	35	6	332.4	"	1
14	Clay Rose	"	24½	3¾	229	R.	
15	Crown Jewell	Large	17¼	9¼	218.9	W.	1
16	Country Gentleman	"	27	8	288.7	"	1
17	Delaware	Small	27	3	243.2	"	
18	Dew-drop Rose	Large	39	7	372.9	R.	1
19	Early Harvest	Medium	25	11¼	293.9	Y.	
20	Early Market	"	21¼	4¾	210.8	R.	
21	Early Norther	Very l'ge	27¼	5½	265.1	W.	
22	Early Puritan	Large	17¾	11	232.7	"	1
23	Early Rose	"	25	9½	277.7	R.	1
24	Early Six Weeks	"	33½	7½	332.4	"	1
25	Everitt	"	29½	9	312.1	"	1
26	Early Fortune	Very l'ge	22	10	259.4	W.	1
27	Early Wisconsin	Large	26	5	251.3	R.	1
28	Early Thoroughbred	"	23¼	6¼	240.9	"	1
29	Freeman	Medium	16¼	10	212.8	W.	1
30	Farmer's Alliance	Large	34¼	5½	322.3	R.	1
31	Good News					W.	
32	Great Divide	Small	7½	1½	73	"	1
33	Green Mountain	Large	14½	3	141.9	Y.	1
34	Harbinger	"	25	8½	269.5	R.	1
35	Houlton Rose	"	30½	3½	275.6	.....	1
36	Harvest Queen	Medium	43½	3½	381	W.	1
37	Howe's Premium	Small	21	5½	216.5	R.	1
38	Honeoye Rose	Medium	25½	1½	216.5	"	1
39	Irish Cobbler	"	13	6½	159.8	W.	1
40	Irish Daisy	Very l'ge	15	3	145.9	"	1
41	King of the Roses	Medium	22½	7½	229.1	R.	
42	Koshkonong	Small	8	1½	77	W.	1
43	Late Puritan	Large	43½	4	385.1	"	1
44	Leonard's Favorite	Small	20½	2½	184.1	R.	1
45	Maggie Murphy	Medium	23½	5	229	"	1
46	Money Maker	"	13½	5½	151.7	W.	1
47	Mill's Endurance	Very l'ge	18	1	154	"	1
48	New Queen	Large	24	4½	231	"	1
49	Ohio, Jr	Medium	21	5½	211	R.	1
50	Orphan	Large	42	2¼	368.9	W.	1
51	Parker's Market	Very l'ge	32½	4	294.2	R.	1
52	Polaris	Medium	25½	7	259.4	W.	1
53	Peerless, Jr	Large	25	4	235.1	"	1
54	Prize Taker	Very l'ge	18	4	178.3	R.	1
55	Pride of Ireland	Medium	15½	4½	166.2	W.	1
56	Queen of the Valley	"	14½	4½	151.7	"	1

Digitized by Google

TABLE I.—COMPARISON OF VARIETIES OF POTATOES.—*Continued.*

Number.	Variety.	Form of top.	Yield.			Color of skin. W, white; R, red; M, mixed.	Per ct. of rot.
			Large.	Small.	Per acre.		
			Lbs.	Lbs.	Bush.		
57	Quick Crop	Large	35¼	5½	240.7	R.	1
58	Reeve's Rose	Very l'ge	37	6	348.6	"	1
59	Rochester Rose	Medium	13	2½	125.7	"	1
60	Rupert's Perfection	Large	19	5½	200.3	W.	
61	Rutland Rose	Very l'ge	26	3½	239.2	R.	1
62	Rural New Yorker No. 2	Large	27½	1	231	W.	1
63	Rose No. 9	Medium	35¼	.....	287.8	R.	1
64	Seneca Beauty	Large	44	2½	378	"	1
65	Sir William	Very l'ge	36	4½	328.3	W.	2
66	Somerset	Large	28½	2½	330.4	R.	1
67	Salzer's World's Fair	Medium	21¼	10½	275.5	W.	1
68	Victor Rose	Large	13	8½	174.3	R.	1
69	Vick's Perfection	"	20	4½	198.6	W.	
70	Vaughan	Medium	44½	7½	419.1	R.	1
71	Vick's Advancer	Very l'ge	31½	5½	302	W.	1
72	White Star	Large	24½	4	229	"	1
73	White Mountain	"	12½	5	141.9	"	1
74	White Rose	Medium	22	3½	206.7	"	1
75	Wilson's First Choice	Large	38½	4½	346.2	"	1
76	Woodhull's Seedling	Very l'ge	32½	4½	303.9	"	1
77	World's Fair	Large	20	6½	213	"	1
78	Woodbury White	Medium	17	8	202.7	"	1
79	White Ohio	Large	13	6	154	"	1
80	Governor Rush	"	22	5	218.9	R.	1
81	Sir Walter Raleigh	"	38½	1	322	W.	1
82	Bovee	Medium	22	6	227	"	1
83	Pink Eye	"	18½	6	198.6	R.	1
84	Livingstone	Large	31	2	267 5	"	1
85	Early Roberts	"	18	1½	159.8	W.	1
86	Fillbasket	"	40½	2½	346.2	"	1
87	Breck's Chance	Medium	38½	4½	348.6	R.	1
88	Prolific Rose	Very l'ge	35½	6	347.2	"	1
89	Pride of the South	Medium	20	3	202.7	W.	1
90	Early Michigan	"	25	6	243.2	"	1
91	Algoma	Large	25½	3	229	"	1
92	Alexander Perfection	Very l'ge	16	6	174.4	"	1
93	Burrns's No. 1	Large	29½	4	271.6	"	1
94	Snow Flake	Medium	7	7½	117.5	"	1
95	Virgirosa	Large	31½	3½	279.7	R.	1
96	King of the Earliest	Medium	18½	6½	202.7	"	1
97	North Pole	"	28½	3½	263.2	"	1
98	Mill's Prize	Large	24½	3	220.9	W.	1
99	Red American Wonder	"	44½	1½	368.9	R.	1
100	New Main Crop	Medium	16½	.....	133.8	"	1
101	White Beauty	Very l'ge	46	3	397.2	W.	1
102	Enormous	Medium	33	2	283.7	"	1
103	Early Dawn (13½ ft.)	"	12½	1	250.5	R.	1
104	Early Andes (2 hills)	"	.....	.....	272.3	"	1
105	Granite State	"	11½	5	135.4	W.	1

Digitized by Google

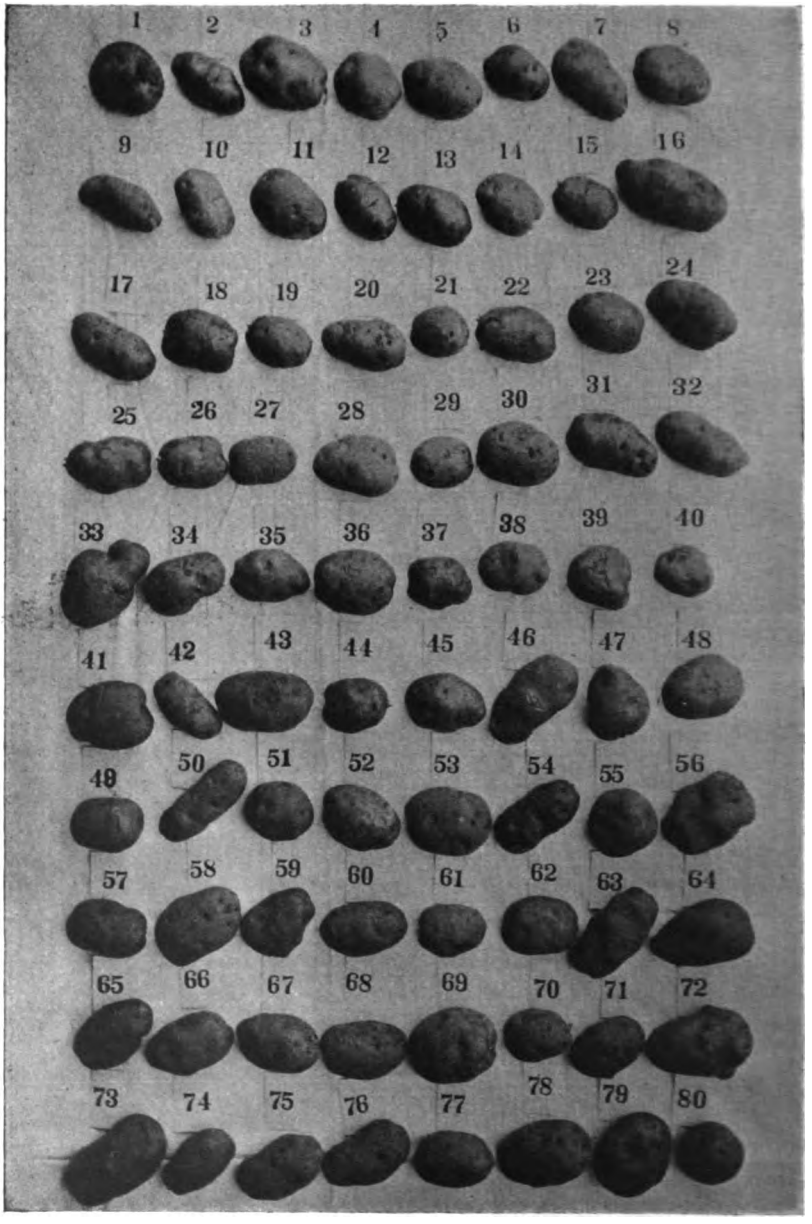


FIG. 14. Varieties of Potatoes.

Digitized by Google

TABLE II.—The Average Comparative Yield of Varieties of Potatoes for the Last Two Potato Seasons, 1896 and 1898. Grown at the Experiment Station.

Number.	Variety.	Yield per acre.	Number.	Variety.	Yield per acre.
1	Uncle Sam	240	50	Orphan	305
2	American Wonder	287	51	Parker's Market	275
3	Banner	228	52	Polaris	251
4	Blush	288	53	Peerless, Jr.	227
5	Brownell's Winner	289	54	Prize Taker	226
6	Burpee's Extra Early	240	55	Pride of Ireland	202
7	Burpee's Superior	193	56	Queen of the Valley	234
8	Bill Nye	220	57	Quick Crop	292
9	Bracy's Rising Sun	228	58	Reeve's Rose	400
10	Carman No. 1	262	59	Rochester Rose	194
11	Carman No 3	258	60	Rupert's Pecfection	252
12	Champion	161	61	Rutland Rose	224
13	Clark's No. 1	263	62	Rural New Yorker No. 2	239
14	Clay Rose	236	63	Rose No. 9	219
15	Crown Jewell	221	64	Seneca Beauty	339
16	Country Gentleman	277	65	Sir William	341
17	Delaware	229	66	Somerset	279
18	Dew-drop Rose	316	67	Salzer's World's Fair	259
19	Early Harvest	271	68	Victor Rose	228
20	Early Market	155	69	Vick's Perfection	296
21	Early Norther	255	70	Vaughan	372
22	Early Puritan	216	71	Vick's Advancer	287
23	Early Rose	272	72	White Star	268
24	Early Six Weeks	221	73	White Mountain	233
25	Everitt	236	74	White Rose	303
26	Early Fortune	204	75	Wilson's First Choice	302
27	Early Wisconsin	242	76	Woodhull's Seedling	317
28	Early Thoroughbred	231	77	World's Fair	199
29	Freeman	194	78	Woodbury White	288
30	Farmer's Alliance	284	79	White Ohio	193
31	Good News	149	80	Governor Rush	297
32	Great Divide	199	81	Sir Walter Raleigh	290
33	Green Mountain	161	82	Bovee	215
34	Harbinger	212	83	Pink Eye	160
35	Houlton Rose	290	84	Livingstone	198
36	Harvest Queen	334	85	Early Roberts	187
37	Howe's Premium	178	86	Fillbasket	320
38	Honeoye Rose	220	87	Breck's Chance	306
39	Irish Cobbler	231	88	Prolific Rose	306
40	Irish Daisy	150	89	Pride of the South	283
41	King of the Roses	274	90	Early Michigan	221
42	Koshkonong	152	91	Algoma	266
43	Late Puritan	351	92	Alexander Perfection	239
44	Leonard's Favorite	246	93	Burrns's No. 1	283
45	Maggie Murphy	215	94	Snow Flake	77
46	Money Maker	187	95	Virgirosa	294
47	Mill's Endurance	136	96	King of the Earliest	192
48	New Queen	260	97	North Pole	191
49	Ohio, Jr.	284	98	Mill's Prize	187

Digitized by Google

TESTS OF VARIETIES IN 1898

For a description of the varieties numbering from 1 to 80 inclusive, the reader is referred to Bulletin 41. For the yield of all varieties grown in 1897, see Bulletin No. 48, Ninth Annual Report. As no descriptions of varieties above No. 80 have been given, they appear in this report beginning on the opposite page.

The accompanying map (page 38) indicates where potato experiments are being conducted; the photographs also indicate the characteristics of each variety.

Our potato plot the past season was a good medium loam soil in a fair degree of fertility. A good sod, which had been previously manured with barnyard manure, was turned under and put in a proper degree of tilth; marked out in rows three feet apart and planted in the usual way, using a fair application of potato phosphate in the hill. At the second hoeing the rows were hilled. After the bugs appeared, the vines were treated twice with Paris green, and twice sprayed with Bordeaux mixture, in combination.

TABLE III.—THE SEVENTEEN VARIETIES GIVING THE LARGEST AVERAGE YIELD, IN ORDER OF PRODUCTIVENESS.

Number.	Variety.	Yield per acre.	Bushels salable.	Remarks.
58	Reeve's Rose	400	333½	Usually more small.
101	White Beauty (1st year)	397	371	See photograph (long).
70	Vaughan	372	310	Oblong, desirable.
99	Red American Wonder (1st year)	368	350	Excellent. See photo.
43	Late Puritan	351	319	Good cropper.
65	Sir William	341	292	Wants clay loam.
64	Seneca Beauty	339	322	Fine pink variety.
36	Harvest Queen	334	306	Desirable potato.
81	Sir Walter Raleigh	322	314	Very choice.
86	Fillbasket	320	301	Good cropper. Photo.
76	Woodhull's Seedling	317	264	Fair cropper.
18	Dew-drop Rose	316	253	Fine Rose type.
87	Breck's Chance (1st year)	306	272	Large red. Photo.
88	Prolific Rose (1st year)	306	255	Medium oval. Photo.
50	Orphan	305	289	Long potato, fine.
74	White Rose	303	253	Fair cropper.
75	Wilson's First Choice	302	269	Fair cropper.

Besides the above, the only varieties to remain in our test are Nos. 1, 2, 4, 10, 11, 16, 17, 24, 34, 38, 40, 44, 45, 47, 52, 53, 57, 61, 62, 66, 71, 80, 93, 95, 102.

Digitized by Google

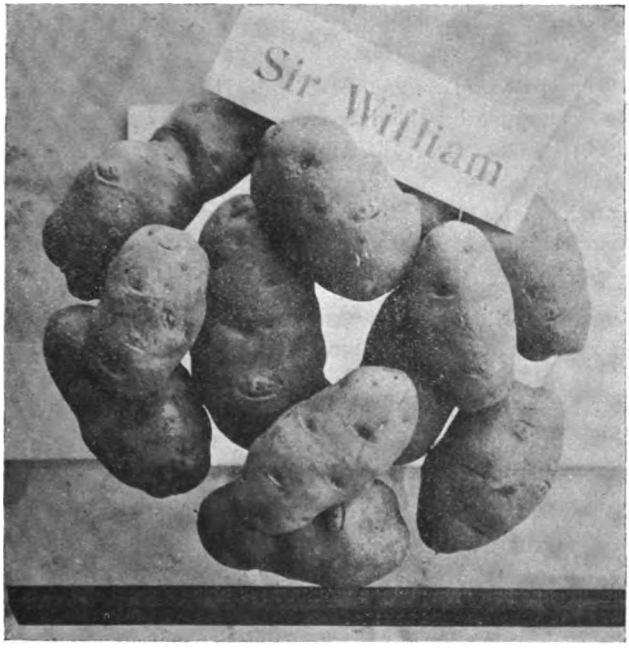


FIG. 15. Sir William Potato (65).

NOTES ON VARIETIES

81. Sir Walter Raleigh (Peter Henderson & Co., New York). This variety is a seedling of the Rural New Yorker No. 2, and another of Mr. Carman's productions. The introducers claim that it closely resembles the Rural New Yorker No. 2, but is more uniform, and yields practically no small tubers; also that it is of better quality and a few days later. The above claims are true of the behavior of the variety here at the Station during the past two seasons. It made strong, heavy vines, and continued to grow late and gave a very fair yield. The tubers were practically all marketable.

82. Bovee (Henderson). A new extra early variety, first grown here in 1897. From the reports, this new variety has been quite generally liked. The vines are dwarf and stocky, dark green in color, and the stem is roundish. The flower is purple. Shape of tuber, elongated, tapering at both ends. I

Digitized by Google

yielded 227 bushels per acre during the past season, 25 per cent. of which were small.

84. Livingston (Livingston & Sons, Columbus, O.). This variety is claimed by the introducers to resemble the Seneca Beauty in general form, differing only in color. It is a strong grower, yielding the past season at the rate of 267½ bushels per acre. Most all of the tubers were of marketable size, nearly equaling the Sir Walter Raleigh in this respect.

85. Early Roberts (James J. Gregory & Sons, Marblehead, Mass.). Said to be a sport from the New Queen, which it resembles, excepting in color,—the Roberts is white. The advantage it has over the parent stock is earliness, being at least a week earlier. We have grown it now two years, with fair results. For some reason, we got better results in 1897 than the past season. It is quite favorably reported upon throughout the state. It is a strong grower, has heavy dark green foliage, and has few small potatoes.

86. Fillbasket (Gregory). This is a white-skinned, main-crop variety, oblong in form, somewhat flattened, and usually smooth and fair. It is a heavy yielder here at the Station, producing at the rate of 346 bushels per acre, a very small per cent. of which were small. The vines were strong, erect, and vigorous.

87. Breck's Chance (Joseph Breck & Sons, Boston). An early red variety. Vines medium; very erect and regular in appearance. Yield very good,—349 bushels per acre, of which 10 per cent. were small.

88. Prolific Rose (Gregory). A new seedling of the Rose type. The vines were very large and spreading. Yield during the past season, 347 bushels per acre, 16⅔ per cent. of which were small.

89. Pride of the South (Johnson & Stokes, Philadelphia, Pa.). Claimed to be a white sport of the Bliss Triumph. Vines of medium size. Yield the past season, 203 bushels per acre, with but few small pototoes. Was very susceptible to blight.

Digitized by Google

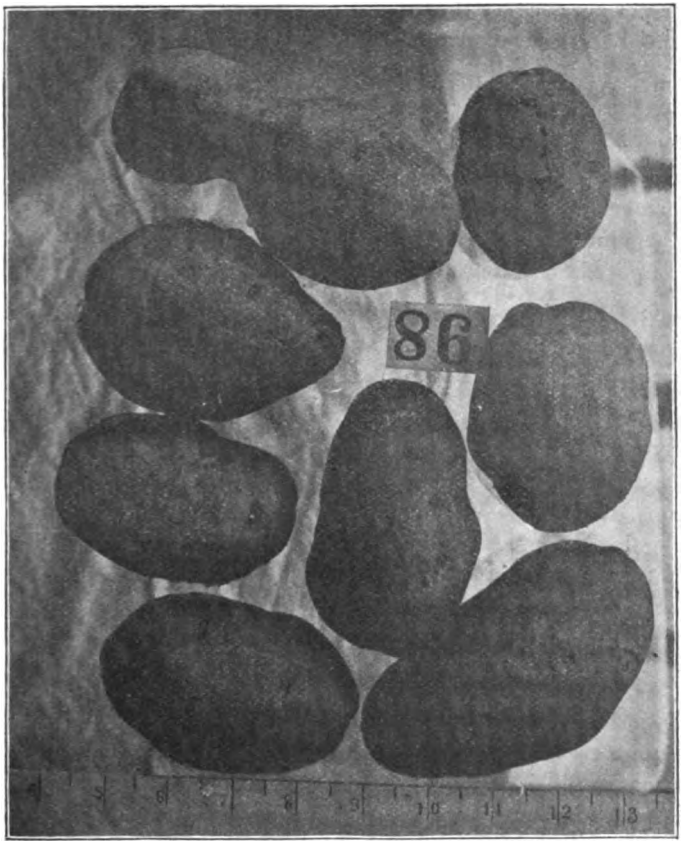


FIG. 16. Fillbasket.

90. Early Michigan (H. N. Hammond, Decatur, Mich.). This is an early potato, claimed by the introducers to be one week earlier than the Early Ohio, and also gives a better yield. We have grown it for the past two years. It is a fair cropper, producing 243 bushels per acre, about 20 per cent. of which were small. Vines regular, strong, large leaf, and medium in size. Color of skin white.

91. Algoma (Hammond). An early white potato of the Hebron class. In the wet season of '97 it produced 303 bush-

Digitized by Google

els per acre, while the past season it yielded only 229 bushels. About 10 per cent. were small.

92. Alexander Perfection. This variety was donated the Station by Mr. Jonathan M. Taylor of Sanbornton, who had them on exhibition at the State Grange Fair in 1896. This is a fine oblong potato, and yielded at the rate of 303 bushels per acre in 1897, but did not do as well the past season. The vines were very large and regular. The small potatoes composed about one third of the crop.

93. Burrns's No. 1 (Hammond). An early white potato, oblong in shape, inclined to a russet color, and with comparatively few shallow eyes. Vines large, strong, erect, and very even; about 12½ per cent. small. Average yield for two years, 283 bushels.

95. Virgirosa (Hammond). This variety was introduced by L. L. Olds of Wisconsin. It is an early white variety, oblong in shape, and quite regular. Vines about 1½ feet high and very spreading, but healthy. About 10 per cent. small potatoes. Average yield for two years, 294 bushels.

96. King of the Earlies (Hammond). A seedling of the Early Ohio, which it resembles very much.

99. Red American Wonder (Gardener & Co.). This potato is quite commonly grown in the northern part of the state, and is considered a very fine variety. When Bulletin 41 was published, Mr. W. A. Gardener of Tilton wrote me that the potato of this variety known in the northern part of the state was a red potato, and not a white, as therein described. After some correspondence in regard to identification of the potato and after raising it here at the Station, I concluded to call it the Red American Wonder. In regard to the same, Mr. Gardener writes as follows: "I find the potatoes sent you were introduced six or eight years ago by John Libby of Aroostook county, Me., into Coös county, as American Wonder. It is the most popular potato grown in that section, and is growing in favor. I have sold them for seed for four or five years. F. C. Clement of Warren, N. H., a potato dealer, told me that the American Wonder grown in Coös county gave the best satis-

Digitized by Google

faction of any potato grown in New Hampshire that he had handled this year." This was one of the heaviest yielders this year. It is a main crop variety, of good size and fine appearance. Vines dark green, very regular and erect, making a very uniform row, almost square top throughout, strong and vigorous. The crop was practically all salable. A fine variety. Yield 369 bushels per acre.

101. White Beauty (O. H. White & Son, Hall's Corners, N. Y.). This is a medium late variety, of new introduction. It belongs to the Burbank and White Star class. Vines very strong and heavy, dark green, standing 2½ feet high and 3 feet broad. Yield at rate of 397 bushels per acre, and only about 6 per cent. were small.

102. Enormous (Gregory). This variety complies very well with the introducer's claims, viz.: "Late, vines very healthy, stalks very stout and tall. Crop remarkable in quantity, potatoes very large, skin very white." The stalks at the Station were only of medium height. Yield 284 bushels per acre, with only 6 per cent. small.

103. Early Dawn (H. C. Marsh). A new red variety. Vines medium in size. Yield 251 bushels per acre, 12 per cent. of which were small.

104. Early Andes (H. C. Marsh). Resembles 103, only slightly more productive; 272 bushels per acre.

REPORTS FROM CORRESPONDENTS

As far as possible reports have been received from all sections of the state upon the results with the potatoes sent from the Experiment Station. In order to simplify matters, each county has been classified by itself and they are taken up in the following pages in alphabetical order. It so happens that Carroll county is the only one not represented.

The tables are computed to bushels per acre so that it is an easy matter to compare the yield with the same varieties in other counties or at the Experiment Statior. The notes following also give the general conditions under which the crop was grown:

Digitized by Google

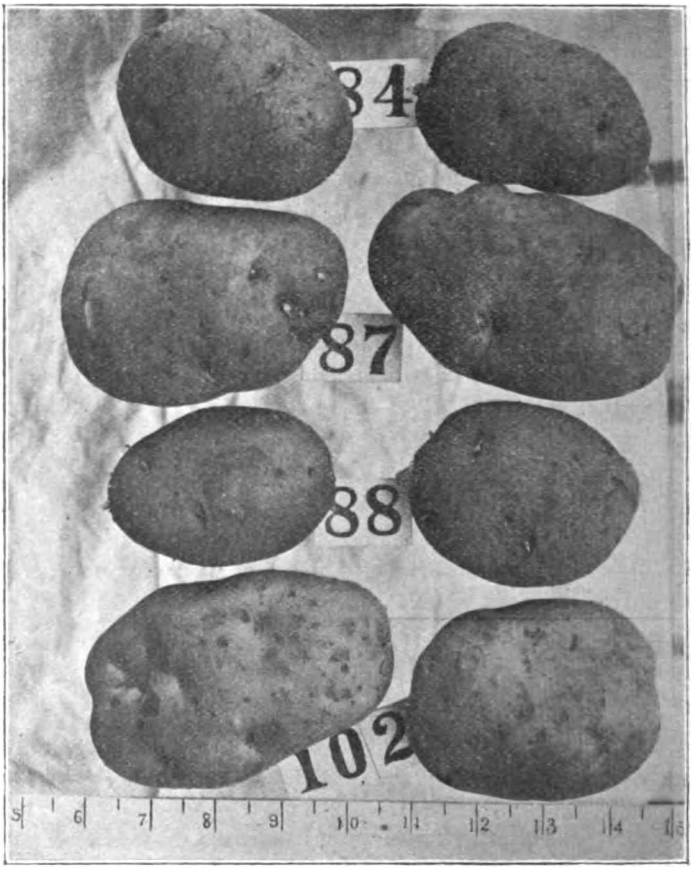


FIG. 17.

84. Livingstone.
87. Breck's Chance.
88. Prolific Rose.
102. Enormous.

BELKNAP COUNTY

NAME OF GROWER.	Soil.	Variety and Yield Per Acre of Each.									
Horace N. Colbath, Center Barnstead.	Clay loam.	No. 65	No. 8	No. 77	No. 78	No. 64	No. 68	No. 74	No. 76	No. 80	No. 75
		801.8 bu.	758.5 bu.	563.5 bu.	541.8 bu.	520 bu.	455.1 bu.	433.4 bu.	346.7 bu.	325 bu.	325 bu.
L. E. Page, Gilm'nt'n Iron Works.	Good loam.	No. 98	No. 2	No. 84	No. 97	No. 65	No. 96	No. 56	No. 79	No. 77	No. 57
		516.2 bu.	472 bu.	451.7 bu.	387 bu.	365.7 bu.	365.7 bu.	365.7 bu.	344.1 bu.	344.1 bu.	279.6 bu.

Digitized by Google

Horace N. Colbath, Center Barnstead.—"The potatoes sent me were planted in a clay loam soil, on May 20th. A light coat of cow manure was plowed in, and a handful of chemicals, mixed according to the formula recommended by the New Hampshire Experiment Station, scattered in each hill. Hoed twice. By Aug. 20th the tops of all varieties were killed by rust. I am satisfied I ought to have sprayed with Bordeaux mixture.

"Sir William (65) were smooth and large, no small ones; Banner (3) were beautiful, smooth and large; White Mountain (73), and World's Fair (77), excepting for rot were fair. Carman No. 3 (11), from another source outyielded the Sir William a little, and were all good size and no rot.

"Shall plant Carmen No. 3, Sir William, and Banner, largely next year."

L. E. Page, Gilmanton Iron Works.—"Besides the above list received from you I planted the Campbell Seedling; the tops and potatoes both look very much like American Wonder (2), and about the same yield. I planted all varieties on hard wood land which has been pastured a good many years."

F. C. Robertson, Tilton.—"The wire worms interfered with my potatoes; I therefore can not give an accurate account. The land used was new hard wood ground. A coat of dressing was plowed in and a little phosphate used in the hill. Sir Walter Raleigh (81) is a fine looking, medium-sized variety."

CHESHIRE COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
J. W. Fletcher, Marlow.	Light loam.	No. 65 374 bu.	No. 57 350 bu.	No. 2 331 bu.	No. 8 260 bu.	No. 11 229 bu.					
George A. Mayo, East Alstead.	Rather light upland.	No. 86 360 bu.	No. 85 318 bu.	No. 90 253 bu.	No. 93 242 bu.	No. 91 205 bu.	No. 88 201 bu.	No. 95 197 bu.	No. 3 196 bu.	No. 89 160 bu.	No. 48 136 bu.
Daniel Wilder, Surry.	Light loam.	No. 8 258.3 bu.	No. 15 234.1 bu.	No. 11 220.8 bu.	No. 16 215.5 bu.	No. 2 198.5 bu.	No. 13 196 bu.	No. 17 185 bu.	No. 10 181.5 bu.	No. 1 121 bu.	
Charles P. Jefts, Marlow.		No. 51 483.5 bu.	No. 54 338.5 bu.	No. 24 314.6 bu.	No. 7 296.8 bu.	No. 26 258.1 bu.	No. 63 258.1 bu.	No. 8 145.2 bu.			

J. W. Fletcher, Marlow.—"The potatoes sent me were given the same treatment as my other potatoes, believing it the only true test I spread about twenty loads of barnyard manure, saved under glass, to the acre, with a handful of hen manure to the hill. The soil was a light loam containing a

Digitized by Google

great many large stones and had not been plowed for a dozen years or more Hills two feet apart. There was no rot to speak of. Banner (3) and Carman No. 3 (11) were poor table potatoes, and rather small. Quick Crop (57) contained many small potatoes; Banner (3) having none. American Wonder (2) and Sir William (65) were a little inclined to be prongy. I should rate the varieties about as the yield per acre indicates. I plant for my main crop the Minister and Green Mountain,—both excellent potatoes, but no better than the Sir William (No. 65)."

Daniel Wilder, Surrey.—"The potatoes received from you were planted upon the Ashuelot river land, a sandy loam. The fertilizer used was a good coating of stable manure. The crop suffered from a dry spell which shortened the crop very much. Carman No. 3 gave the largest per cent. of marketable tubers."

George A. Mayo, East Alstead.—"Potatoes were planted on rather light upland, of medium moisture. Corn was raised on the plot the year previous, with a good coat of stable manure.

"Ground was twice plowed and thoroughly pulverized. Furrowed by running a one-horse plow each way, so as to get good depth,—drew back some of the fine dirt to bottom of furrow,—sprinkled in potato fertilizer, 600 pounds to acre, and mixed with the fine soil. Cut tubers to two eyes and planted fifteen inches apart, and four to five inches deep,—rows two and a half feet apart. Cultivated frequently and kept free from weeds. Did not treat for blight or scab and had little trouble from them.

"At time of digging, measured space occupied by each variety, weighed the potatoes and estimated yield per acre, and my notes were made at the time on that basis. Dug early in September.

"89. Pride of South. Grow compactly in hill almost none below cooking size, scabbed a little. Yield 160 bushels per acre.

"82. Bovee. Very few small, 196 bushels per acre, good quality and appearance.

"85. Early Roberts. Good size, few small. Have never seen a nicer looking lot of potatoes as they lay upon the ground after digging. Yield 313 bushels per acre.

"95. Virgirosa. Of good cooking size, compact in hill, 197 bushels per acre. Desirable.

"90. Early Michigan. Compact in hill, very few small, 253 bushels per acre. Promising.

"93. Burrns No. 1. Few small, one decayed tuber found,—the only one found in the ten varieties,—242 bushels per acre.

"88. Prolific Rose. Fine appearance, cooks about like Early Rose, 201 bushels per acre.

"86. Fillbasket. Average large, practically no small ones, near the surface and close to stock. Very promising, good quality, 360 bushels per acre.

"91. Algoma. Fine appearance, free from scab, good size, promising, 205 bushels per acre.

"92. Alexander Perfection. Merits continued trial. Looks well and quality good, 245 bushels per acre.

Digitized by Google

"Have raised a number of other varieties the past season. The Enormous is a large potato of good appearance, yield 313 bushels. Early Thoroughbred yielded well, but were not shapely as some, and hardly met expectations. Howe's Premium, 230 bushels per acre, cooks well at time of digging. Several of the older varieties I shall discard, as there are too many small ones, as the Delaware, Early Rose, Late Rose, Lee's Early Favorite, Beauty of Hebron, etc. The American Wonder yielded a little better than any other, and is quite good. The Joseph is a good yielder, and of good quality; I regard it as among the very best. New Queene gave lowest yield of any, 136 bushels per acre; it does not succeed with me. For table use the varieties sent were so uniformally good that I am not able to decide, from one year's trial, which would be the best for this locality. Shall try all another year. Did not weigh the small ones separately, for the reason that they amounted to very little in any variety. While none of the tubers was very large, nearly all were of good size for table use. This might have been owing to exceptional conditions of the season.

"I believe the first rule in potato culture should be, "Pulverize, *pulverize*, PULVERIZE the soil." With us the newer varieties seem to have more vigor and give better satisfaction."

Charles P. Jefts, Marlow.—"The potatoes received from you were planted on moist loam and dug September 8th. There was very little rot in any of them. All of the varieties reported upon I am saving for future use."

COÖS COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.								
W. H. Forbes, Groveton.	Light clay loam.	No. 95 832.8 bu.	No. 92 771.4 bu.	No. 91 756.4 bu.	No. 93 726 bu.	No. 86 680.6 bu.	No. 89 635.3 bu.	No. 81 605 bu.	No. 88 574.8 bu.	No. 85 529.4 bu.	No. 90 452.8 bu.

W. H. Forbes, Groveton.—"The kind of soil where the varieties were planted was a light clay loam. All of the rows from which the above computations were made were sixteen feet long. All of the varieties rotted more or less, being on the average about one fifth of the total. The long severe drouth in June and July injured the crop very much; and the very hot weather the last of August and the first part of September is the cause, in my opinion, for the large amount of rot. I believe the Algoma, Alexander Perfection, and Virgirosa are the best kinds to raise in my part of the state."

E. Geo. Rogers of Colebrook, and J. C. Poore of Stewartstown, reported that potatoes were a light crop this season with them, and the rot and late frosts rendered their reports valueless.

Digitized by Google

GRAFTON COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
Wm. S. Gove, Lebanon.	Rich loam.	No. 88	No. 86	No. 91	No. 89	No. 90	No. 93	No. 85	No. 92	No. 82	
		726 bu.	645.3 bu.	457.1 bu.	430.2 bu.	376.4 bu.	322.7 bu.	295.7 bu.	268.9 bu.	215.1 bu.	
W. W. Chamberlin, Woodsville.	Sandy loam.	No. 68	No. 64	No. 65	No. 76	No. 75	No. 77	No. 74	No. 80	No. 73	No. 81
		568.7 bu.	445.5 bu.	403.3 bu.	403.3 bu.	402.4 bu.	332.7 bu.	330 bu.	315.2 bu.	313.5 bu.	267.3 bu.
Albert Pinneo, Hanover.	Medium loam.	No. 51	No. 41	No. 54	No. 33	No. 57	No. 43	No. 60	No. 63	No. 31	No. 62
		572 bu.	539 bu.	520.4 bu.	506 bu.	473 bu.	457 bu.	440 bu.	429 bu.	374 bu.	297 bu.
Geo. N. Burnham, No. Dorchester.	Rich sandy loam.	No. 65	No. 64	No. 81	No. 80	No. 73	No. 76	No. 58	No. 74	No. 75	No. 77
		399.3 bu.	322.7 bu.	291 bu.	258.1 bu.	240 bu.	237.9 bu.	198.3 bu.	198.3 bu.	198.3 bu.	198.3 bu.
Arthur Wood, Bath.	Rich loam.	No. 68	No. 74	No. 80	No. 75	No. 11	No. 67	No. 65	No. 81	No. 73	No. 77
		375.1 bu.	326.7 bu.	326.7 bu.	314.6 bu.	304.2 bu.	278.3 bu.	255.8 bu.	242 bu.	242 bu.	229.9 bu.
Geo. W. Atwood, Ashland.	Int'rvale sandy loam.	No. 97	No. 84	No. 77	No. 79	No. 61	No. 98	No. 96			
		349.5 bu.	242 bu.	242 bu.	166.4 bu.	145.2 bu.	107.5 bu.	100.8 bu.			
C. P. Olin, Lyman.	Black loam.	No. 90	No. 86	No. 81	No. 93	No. 82	No. 57	No. 28	No. 91	No. 2	No. 89
		302.9 bu.	233.3 bu.	228.3 bu.	228 bu.	207.4 bu.	201.6 bu.	201.6 bu.	189.1 bu.	176 bu.	175.4 bu.
J. W. Blair, Woodsville.	**Light sandy loam.**	**No. 80**	**No. 92**	**No. 96**	**No. 26**	**No. 16**	**No. 66**				
		272.3 bu.	**243.1 bu.**	**228.7 bu.**	**210.4 bu.**	**187 bu.**	**188.3 bu.**				
Elmar Moulton, Haverhill.	**Old pasture.**	**No. 86**	**No. 88**	**No. 93**	**No. 85**	**No. 22**	**No. 89**	**No. 90**	**No. 19**	**No. 26**	
		231.9 bu.	**228.5 bu.**	**228.5 bu.**	**221.8 bu.**	**207.4 bu.**	**191.6 bu.**	**184.4 bu.**	**184.2 bu.**	**152.4 bu.**	

Digitized by Google

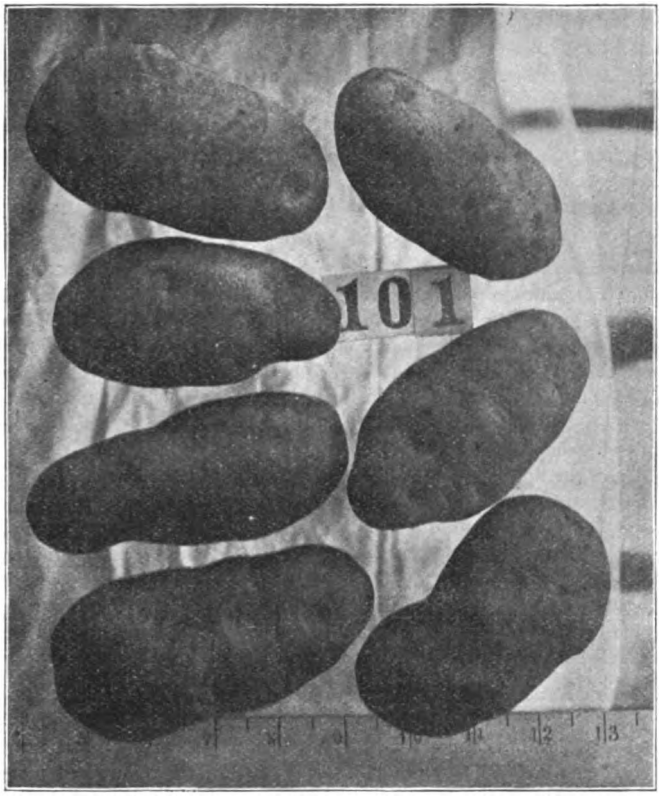


FIG. 18. White Beauty.

W. W. Chamberlain, Woodsville.—"My potatoes raised from the seed sent me by you are a fine lot, perfectly free from rot, and not enough scab present to take any account of. All varieties were planted on May 6th, and dug on August 27th. The soil was a sandy loam. The fertilizer used was to spread on manure in the fall, which was plowed in in the spring; then 1,200 pounds of Buffalo potato phosphate was applied in drills.

"Sir William (65) and Governor Rusk (80) had a few prongs on them, while the others were very smooth, and all of them would please any man. Seneca Beauty (64), Victor Rose (68) and World's Fair (77) are my choice from yield and looks. Sir Walter Raleigh (81) are very large but handsome.

W. G. Gove, Lebanon.—"The soil in which the varieties were planted was greensward and of a rich loam, plowed eight inches deep and harrowed twice over with a spring-tooth harrow. Many of the varieties did fairly well, but I am inclined to think they will do better next season. From a piece of

Digitized by Google

land ten rods square I had one hundred and sixty bushels of nearly all salable potatoes."

H. H. Harris, Etna.—"I enclose report on potatoes received from you. I regret to say I overlooked the measuring of the rows. They were grown on a light loam; were sprayed three times with Bordeaux mixture; were all entirely free from rot. No. 2 seems to lead all the rest, being very handsome and great yielders. Nos. 1 and 10, large and handsome; 11 and 16, clean and fine looking; 3, 5, and 17, inclined to be scabby, the last named very much so with many small ones."

Elmore Moulton, Haverhill.—"I now report result of potato planting this season. You sent me fourteen varieties, of which I gave four to a friend and planted ten myself. The land was a plat previously pastured,—plowed last fall, fertilized with stable manure, and, in addition, a handful of phosphate in each hill at time of planting. I planted the entire plat to potatoes. A dry spell in the early season had a bad effect upon the yield, but the quality in all varieties proved very good. They were planted May 13, cut in three or four pieces, one piece in a hill. The result is as shown in table.

"Pride of the South (89) was the earliest by two weeks. Burrns's No 1 (93) and Early Roberts (85) were large, handsome, and even in size. Algoma (91) is a very attractive potato. Early Fortune (26) was very scabby and ill. shaped. Fillbasket (86) was later than the others, but seems desirable. I may add, that for my main crop I raised Maggie Murphy (45) an excellent potato and very productive; Green Mountain (33), a white, handsome, very desirable variety; Tyler, the best "next summer" kind I know of; Polaris (52), which I shall never plant again, and the old reliable Pearl of Savoy."

A. Pinneo, Hanover.—"The potatoes received from the Experiment Station were planted May 7th and dug the latter part of September. Hills eighteen inches apart. Soil, medium loam. Applied about ten cords of cow manure per acre, on surface. Phosphate one side of the hill, three hundred pounds per acre. Hen manure, a handful. Ashes at first hoeing."

A. M. Poor, Landaff.—"I was not present when the potatoes sent me were dug; each variety was kept separate, however. The Country Gentleman and Sir William yielded about the same. Carman No. 3 tubers were larger and more even in size than any other variety. The Reeve's Rose were more in number than any other variety, and were near the yield of the Country Gentleman, and on some soils would yield a larger crop. They were all free from blight, but we were badly troubled by bugs this season. They were raised on hard-wood and pine land. Land broken up in the spring, manure plowed under. Phosphate used in the hill. I think they all would average about three hundred bushels per acre. The rust struck here early in the season, and so the potatoes were dug the first week in September.

"The four varieties of potatoes sent me last year were planted again this season where corn was raised last year, using no manure this year. They were all of good quality and no rot. American Wonder (2) was the finer looking, but Sir William yielded the most. There were but few small ones."

Digitized by Google

Arthur Woods, Bath.—"The varieties received this year were all planted in old strawberry bed loam, which resulted in all of them being more or less scabby. They were dug September 1st, and were free from rot. Victor Rose (68) were the earliest. Governor Rusk (80) were very uneven, varying from very small to one pound in size."

George W. Burnham, North Dorchester.—"The potatoes were planted the 25th of May, on sandy loam, towards the south and east. Last year the land had a light coat of stable manure, and raised beans. This year a good dressing of stable manure was applied, and the seed cut one eye to the piece and two pieces in hill, with phosphate in hill. But each year has its drawback. We had a severe drouth of five weeks, not one drop of rain, and seven without enough to wet down the hills; so the yield was smaller than it would otherwise have been. Although the potatoes were fair size, they did not average large. Enough set, however, to have had a large crop. Sir Walter Raleigh (81) rotted and were scabby; all other varieties equally good."

C. P. Olin, Lyman.—"The soil in which the potatoes were planted was a black loam, lying across a knoll. There was practically no rot, excepting that of the Sir William, which was about fifty per cent., and besides, very scabby. For an early potato I prefer the Early Roberts (No. 85); the vines plainly indicated that it led all the others in growth. For market, should prefer the Fill Basket (86); it grew the largest number of salable potatoes."

J. W. Blair, Woodsville.—"The potatoes sent me were planted May 11th, in a light, sandy soil. King of the Earliest (96) was ripe and dug upon Aug. 20; the remainder were dug Aug. 30th Somerset (66) and Country Gentleman (16) did not do as well as the others."

G. W. Atwood, Ashland.—"The potatoes received from the Experiment Station were planted on river intervale land, above high water; sandy loam, broken up last fall. A little manure was spread on furrows and well harrowed in this spring. Planted May 7th, in rows three feet apart, dropping the seed, which was cut to two eyes to the piece, about fifteen inches apart in the row. The rows were furrowed out about four inches deep, and 1,500 pounds of Essex Complete Potato Fertilizer was spread in the rows. A 35-pound chain, folded, was used to fill the furrows and mix the fertilizer. Covered with a spring-tooth harrow, first lengthwise, and then cross the furrows; a few were dragged out. The piece was harrowed with a spring-tooth harrow before many of them came up; a Breed weeder was run through two or three times, and a light hoeing given. About July 20th the barn grass came up, and we went through them again. Sprayed once with the Bordeaux mixture. The Carman No. 3 (11) sent me last year, were very good. My potatoes did not set well, very few in a hill, but all good size; some hills had but one or two very large potatoes. I attributed the cause to dry weather."

Digitized by Google

HILLSBOROUGH COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
George F. Clough, East Weare.	Light loam.	No. 43	No. 63	No. 51	No. 57	No. 41	No. 54	No. 62			
		159.6 bu.	144.7 bu.	141 bu.	140.8 bu.	132.7 bu.	100.8 bu.	75 bu.			
Pierce Bros., Hollis.	Old garden.	No. 28	No. 10	No. 2	No. 11	No. 1	No. 17	No. 16	No. 8	No. 3	No. 5
		431 bu.	352 bu.	333.3 bu.	271 bu.	280.7 bu.	176.8 bu.	162.8 bu.	159.5 bu.	143.5 bu.	129 bu.
D. G. Roberts, Goffstown.	Gravelly loam.	No. 85	No. 48	No. 57	No. 33	No. 66	No. 86	No. 58	No. 90	No. 96	No. 82
		260 bu.	260 bu.	240 bu.	224 bu.	224 bu.	224 bu.	208 bu.	208 bu.	208 bu.	240 bu.
Wm. H. Huse, Manchester.	Black loam.	No. 65	No. 2								
		242.2 bu.	120 bu.								

George F. Clough, East Weare.—"The potatoes sent me were planted on new ground of a light loam, not very dry. I spread on a good crop of stable manure and used also a compost of hen manure, half and half, but no phosphate. Think I missed it by not using the latter. I Paris greened them but once. We have not had a good crop of potatoes in this section now for two years. The varieties I liked very much; of those received this year are Late Puritan (43), Prize Taker (54), and Parker's Market (51).

"Of the varieties received last year I planted same again. Uncle Sam (1) is too late for this place, as it is very frosty here. Sir William (65), Reeve's Rose (58), and Orphan (50) did very well and I shall plant Sir William and Orphan as a main crop next year. The new varieties did as well, and in most cases better than the kinds that have been planted here right along."

Pierce Brothers, Hollis.—"Report of ten varieties of potatoes sent from Experiment Station. Planted April 19th and gathered September 16th. Planted upon an old garden, using small handfuls of phosphate in a drill. Used drill process of planting and hilled up somewhat in hoeing. Applied Paris green to destroy bugs. Bugs not as plenty in any of our fields as usual. Blight did not effect the vines which were uncommonly green and luxuriant.

"The yield, while not large, was in most varieties fair, and of excellent quality. The amount of rot in our fields was trifling. We found the experiments interesting, and take pride in our boxes of potatoes.

"The potatoes were cut to one eye and planted in drills. Some rotten ones among Nos. 16 and 11, very few scabby ones, in fact so little of it that we made no account of it. We think the Early Thoroughbred the finest potato

Digitized by Google

(*i. e.*) in yield, shape, and size, while Carman No. 3 is the handsomest. Brownell's Winner, while giving an average yield, produces fine shaped, marketable red tubers."

Wm. H. Huse, Manchester.—"Of the varieties received last year, I planted two again this season, Sir William (65) and American Wonder (2). The seed was cut one eye to the piece and planted in hills about eleven inches apart. The land was a black loam, with sandy sub-soil. and rather wet."

D. G. Roberts, Goffstown.—"I send herewith my report on potatoes for 1898. Soil, gravely loam, with a slight western incline. Previous to 1897, long in grass. Plowed in spring of 1897 and grew ensilage corn with fertilizer only. Well plowed in fall. Plowed once and harrowed six times in spring of 1898. No manure. One ton per acre of Bradley's Potato Fertilizer. Length of row, one rod. Rows to a rod in width, six. Each row occupied one sixth of a square rod. Each row seeded as near alike as possible. Furrows six inches deep and seed in bottom, then lightly covered, then fertilizer scattered along the row, and then seed covered two inches deep. Horse hoed three times and hand hoed once. Bugs kept off with Paris green and plaster. All planted April 19, 1898. No rot in any lot.

"All varieties dug after the foliage had turned yellow. The three best early, for market, were Nos. 85, 82, and 26. The three best medium, for market, were Nos. 11, 33, and 86. Nos. 89 and 91 are very promising, but this was my first trial of them. Nos. 48, 66, 90, and 93 rank high as a second early market potato."

Digitized by Google

MERRIMACK COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
Stillman Clark, Danbury.	Old garden soil.	No. 43	No. 63	No. 54	No. 51	No. 33	No. 41	No. 62	No. 57		
		80.7 bu.	80.7 bu.	74.6 bu.	71 bu.	65.2 bu.	60.5 bu.	58 3 bu.	57.6 bu.		
J. R. Hills, Penacook.	Light sandy loam.	No. 82	No. 91	No. 92	No. 86	No. 93	No. 88	No. 95	No. 90	No. 98	No. 65
		244 bu.	230.5 bu.	217.8 bu.	216 bu.	215.2 bu.	200.3 bu.	195.9 bu.	195 bu.	184.2 bu.	148.7 bu.
F. W. Stevens, E. Pembroke.	Sandy loam.	No. 68	No. 1	No. 65	No. 81	No. 73	No. 80	No. 2	No. 75	No. 76	No. 77
		414.8 bu.	325 bu.	302.5 bu.	259.3 bu.	259.2 bu.	242.4 bu.	242 bu.	226.9 bu.	220 bu.	207.4 bu.
F. B. Sawyer, Webster.	Medium loam.	No. 2	No. 28	No. 16	No. 10	No. 8	No. 17	No. 3	No. 5	No. 11	No. 1
		456.2 bu.	456.2 bu.	369 bu.	268 bu.	233 bu.	226 bu.	177 bu.	160 bu.	152.6 bu.	150 bu.
J. M. Snyder, Webster.	Sandy loam.	No. 58	No. 98	No. 65	No. 68	No. 80	No. 3	No. 70	No. 81	No. 64	No. 74
		532.6 bu.	435.6 bu.	416.4 bu.	407.4 bu.	346.6 bu.	326.7 bu.	302.6 bu.	283.5 bu.	273.2 bu.	255 bu.
F. O. Melvin, Bradford.	Medium loam.	No. 10	No. 17	No. 8	No. 2	No. 5	No. 16	No. 3	No. 11	No.	No.
		good	good	good	good	light	light	light	light		

Digitized by Google

Stillman Clark, Danbury.—"The potatoes received from you were planted May 24th, and dug October 1st. Hills, three by three feet, and soil old garden ground. No manure was used, but 300 pounds of Bradley's Potato Fertilizer was applied to the acre. The soil was dry and rather sandy. The best yield was Late Puritan (43) and Prize Taker (54). The ground was not favorable and the rust was very troublesome. Plenty of potatoes set, but about one half did not reach salable size. I have the best results from the White Jersey potato; have planted it for seven years, and it is as productive now as it was when first planted."

John C. Mills, North Dunbarton.—"The potatoes I planted were all affected by rot, more or less. Of the varieties you sent, the Governor Rush (80) yielded almost double the others, and was large and fine-looking"

Francis B. Sawyer, Webster.—"The potatoes were planted upon hill land of medium moisture. Ordinary culture was given, and the same number of hills and amount of seed was given each kind. The Carman No. 3 was not as badly attacked by potato bugs as the others. The American Wonder (2) were nearly all marketable, likewise Carman No. 1 (10), Bill Nye (8), Banner (3), and Delaware (17). Country Gentleman (16) were about one quarter small. Carman No. 3 (11) contained many small potatoes."

J. M. Snyder, Webster.—"No. 58, Reeve's Rose, turned out the best, and were fine potatoes, but had quite a lot of small ones, and not quite as smooth as Banner (3). These were all good-sized, and a very pretty potato. No. 73 is not worth planting. Reeve's Rose (58), Banner (3), Mills' Prize (98), Sir William (65), Uncle Sam (1), and Victor Rose (68), are all good potatoes. The land I planted on was a moist, sandy soil. I under-drained it this spring; it was so wet last year I did not get hardly any potatoes. It was taken out of pasture two years ago, and manured, although not heavily."

F. W. Stevens, East Pembroke.—"I planted the varieties you sent me, upon a sandy loam, reclaimed from a pasture, which had borne three heavy crops of corn, and therefore was dressed each year with cellar manure and phosphate. This season, a good dressing of cow manure from the cellar was turned under, and 400 pounds of potato phosphate per acre was applied in the drill. The hills were fifteen to eighteen inches apart, and the seed cut to from one to three eyes to the piece. There were few in a hill, but of good size."

"The Victor Rose (68) extra large and fine, little rot, and very few small ones, on the whole, the best of all I planted. Uncle Sam (1) large and fine, no rot, no small ones. Sir William (65) good yield, large and fine. Sir Walter Raleigh (81) nearly all large and smooth, a fine potato. The others, with the exception of Wilson's First Choice (75), White Rose (74), and Governor Rush (80) were very good. These three contained many small ones."

John R. Hill, Penacook.—"The potatoes were planted on light, sandy loam. The sod was broken in the spring, and a good coating of stable manure was harrowed in. The seed was planted May 2 in rows three and one half feet, and hills eighteen inches in the row. Bovee (82) medium early, large, smooth, no small ones. Early Michigan (90), large, and all smooth, very early. Burns No. 1 (93), smooth and very handsome. Fillbasket (86) a medium late,

Digitized by Google

generally large, few small. Virgirosa (95) medium early, uniform in size, very handsome. The remainder were more or less scabby, or too small. Sir William was very poor. My main crop was New Queen (48); there were very few in a hill, but nearly all were of good size."

F. O. Melvin, Bradford.—"Planted May 18, 1898, on ground broken up in fall of 1897, with manure plowed under; well harrowed in spring, and planted in drills three feet apart, eighteen inches apart in drills, with Reed's Special Potato Manure in drills. Soil medium. Most of the varieties were smooth, with a very few prongy ones, and not much rot among them. The season was much better than last year for the growing of potatoes, but I did not have as large a yield as I usually have."

ROCKINGHAM COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
Thomas Barrett, Newton Junction.	Heavy.	No. 68	No. 57	No. 43	No. 33	No. 51	No. 62	No. 41	No. 60	No. 31	No. 54
		190.7 bu.	165 bu.	165 bu.	110 bu.	102.7 bu.	98.5 bu.	95.3 bu.	91.7 bu.	73.3 bu.	73.3 bu.
J. L. Currier, South Hampton.	Gravelly loam.	No. 41	No. 63	No. 60	No. 81	No. 62	No. 82	No. 31	No. 33		
		168.3 bu.	125.3 bu.	115.9 bu.	99 bu.	95.9 bu.	88.7 bu.	66 bu.	60.5 bu.		
Horace M. Hills, Plaistow.	Heavy loam.	No. 68	No. 65	No. 81	No. 27	No. 75	No. 64	No. 2	No. 43	No. 38	No. 78
		283.1 bu.	272.2 bu.	242 bu.	201.7 bu.	190.8 bu.	189 bu.	185.7 bu.	182.4 bu.	171 bu.	169.9 bu.
C. E. Smith, Exeter.		No. 92	No. 88	No. 91	No. 95	No. 83	No. 52	No. 90			
		229.3 bu.	221.2 bu.	174.5 bu.	152.1 bu.	145.2 bu.	131.5 bu.	114.3 bu.			

Thomas Barrett, Newton Junction.—"The soil in which the potatoes from the Experiment Station were planted was new ground, which was heavy and rocky. The only fertilizer used was Stockbridge's Potato Manure, at the rate of 800 pounds per acre. There was no rot in any of the varieties. The ones I prefer are Quick Crop (57), Rose No. 9 (63), Late Puritan (43), and Rural New Yorker No. 2 (62)."

J. L. Currier, South Hampton.—"The potatoes received from the Experiment Station were planted in a gravelly loam soil. The previous season, the land was cropped with corn and Hungarian, using as a fertilizer a part each of manure and fertilizer. The potatoes were planted in drills three feet apart, using one or two eyes to the piece, and dropping them about one foot apart in the row. The fertilizer was one ton of Stockbridge Potato Manure per acre, one half harrowed in, and the remainder in drill. They came up

Digitized by Google

well, and by August 1st, the vines covered the ground. The vines remained green until September 1st. They were dug on September 30. I lost, by rot about one third of the crop. Judging by looks, should prefer Sir Walter Raleigh (81), Rose No. 9 (63), and King of the Roses (41); next Bovee (82), and Uncle Sam (1)."

H. M. Hills, Plaistow.—"The potatoes received from you were planted May 24, on land broken up in 1897, and planted to potatoes. Soil was a rather heavy loam, and was furrowed out, and a fair amount of hen manure put in drill. Wood ashes were put around potatoes at the second hoeing. They were well cared for throughout the season, and dug on September 3. Found no rot. The season was unfavorable for best results. Victor Rose (68), American Wonder (2), Wilson's First Choice (75), Sir William (65), and Seneca Beauty (64) yielded the largest per cent. of good potatoes."

Charles E. Smith, Exeter.—"I enclose the results from the potatoes received from you last spring (see table). All of my varieties were bothered, more or less, with rot. The varieties I have been growing are the Late Rose, Delaware (17), and Fillabsket (86). The Delaware rotted least of all. Quick Crop (57) is a good potato, but rots too badly. Sir William (65) might do well in a better season."

STRAFFORD COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
H. E. Coffin, p. o., Berwick, Me.	Good loam.	No. 68	No. 80	No. 65	No. 75	No. 19	No. 76	No. 77	No. 58	No. 74	No. 64
		314.8 bu.	very h'avy	267.9 bu.	259.3 bu.	237.7 bu.	229 bu.	224.7 bu.	207.4 bu.	181 bu.	272.9 bu.
George D. McDuffee, Dover.	Rather dry loam.	No. 28	No. 16	No. 10	No. 2	No. 8	No. 57	No. 3	No. 65	No. 17	No. 11
		239 bu.	208.1 bu.	208.1 bu.	208.1 bu.	200 bu.	178.5 bu.	169.4 bu.	145.2 bu.	142.2 bu.	142.2 bu.
Eli Meader, Rochester.	Sandy loam.	No. 82	No. 85	No. 93	No. 95	No. 86					
		158.8 bu.	133.2 bu.	131.1 bu.	123 bu.	103.7 bu.					
A. E. Ross, Somersworth.	Dark sandy loam.	No. 90	No. 93	No. 87	No. 81	No. 89	No. 95	No. 80	No. 96	No. 83	No. 92
		435.6 bu.	419.5 bu.	403.2 bu.	371 bu.	354.9 bu.	338.7 bu.	322.6 bu.	322.6 bu.	306.5 bu.	290.3 bu.
J. H. Stiles, Strafford Centre.	Clay bottom.	No. 88	No. 89								
		193.6 bu.	189.6 bu.								
Lucien Thompson. Durham.	Light loam.	No. 33	No. 57	No. 31	No. 11	No. 16	No. 69	No. 28	No. 73	No. 76	No. 5
		617 bu.	484 bu.	403.3 bu.	348.5 bu.	206.6 bu.	173.4 bu.	157.5 bu.	144.4 bu.	98.3 bu.	83.3 bu.

Digitized by Google

Lucien Thompson, Durham.—"Soil light, plowed spring of 1898. Crop, in 1897, only one-half ton of June grass per acre. No manure; used 800 pounds Bradley Potato Fertilizer in furrow. Furrowed out and covered by horse power. Hoed, and Paris green used twice. Only ordinary care. Potatoes free from scab, and not more than four quarts of rotten potatoes found. Two years' trial show me that Green Mountain (33) are the best yielders, and the most profitable for a general crop. I shall continue the Green Mountain and Carman No. 3 (11) for my field crop of 1899, and plant few early kinds for my own use. The Carman No. 3 stands blight better than my other kinds, tops being the last to die."

H. E. Coffin, Berwick, Me.—"The varieties of potatoes received from you were planted in good season, as soon as the ground was warm. The soil was a mellow and rich loam on high ground, and sloping to the south. I spread on a heavy coat of stable manure, and used a handful of Swift's Lowell Fertilizer in the hill. The yield was not very large. The Victor Rose (68) were large and smooth, extra fine. Governor Rush (80) gave the largest yield, nearly all smooth and nice. All of the others were also smooth and fine excepting Reeve's Rose (58), which were one fourth small, and quite scabby. Algoma (91) small and scabby, and White Mountain (73) rather small. Early Harvest (19) was the earliest; fine, smooth, but not very large."

George D. McDuffee, Dover.—"The soil in which the potatoes were planted was a loam not ordinarily wet. The rows were twenty feet long, and twelve hills to the row. Date of planting, May 1. All varieties rotted, more or less. Early Thoroughbred (28), early and all right, Carman No. 3 (11), handsome, Uncle Sam (1), little rot, medium early, Delaware (17), many lack vitality, Sir William (65), no good. Carman No. 1 (10) scabby, Banner (3), promising, excepting the rot."

Eli Meader, Rochester.—"The soil in which the varieties were planted was a sandy loam. Only with a few exceptions, namely, Burrns's No. 1 (93) and Virgirosa (95) were free from rot. The only ones rotting quite badly were Fill Basket (86) and Alexander Perfection (92)."

A. E. Ross, Somersworth.—"The land that I planted was used for potatoes the year before, with an application of 23 per cent. of S. P. Guano. This year I used eight cords of barnyard manure, and one-half ton of Guano per acre. I planted Green Mountain (33) of my own seed, on one side, and Maggie Murphy (45) on the other side. None of the varieties were as large as my Green Mountains, and nowhere with the Maggie Murphys. I saved only Early Michigan (90) and Breck's Chance (87) for trying again. There was no scab; I dusted all my potatoes, after they were cut, with flour of sulphur, and thought it helped them. Soil a dark, sandy loam."

J. H. Stiles, Strafford Centre.—"All of the varieties sent me rotted badly; taking them as a whole, fully two thirds were lost. They were planted in a clay soil, on a side hill."

Digitized by Google

SULLIVAN COUNTY

Name of Grower.	Soil.	Variety and Yield Per Acre of Each.									
Geo. L. Deming, Cornish.	Early land.	No. 58	No. 85	No. 88	No. 82	No. 90	No. 98	No. 95	No. 91	No. 1	No. 92
		588 bu.	499.1 bu.	408.7 bu.	394.8 bu.	393.2 bu.	393.2 bu.	363 bu.	349.5 bu.	347.9 bu.	322.7 bu.
A. W. Fairbanks, South Cornish.	Clay loam.	No. 16	No. 35	No. 7	No. 27	No. 28	No. 44	No. 17	No. 3	No. 56	No. 76
		364 bu.	270 bu.	270 bu.	267 bu.	267 bu.	240 bu.	240 bu.	225 bu.	209 bu.	201 bu.
W. H. Howard, Grantham.	Gravelly soil.	No. 92	No. 95	No. 86	No. 91	No. 89	No. 88	No. 93	No. 85	No. 90	No. 82
		229.6 bu.	211.7 bu.	205.7 bu.	199.6 bu.	199.1 bu.	187.5 bu.	187.5 bu.	186.9 bu.	184.6 bu.	157.3 bu.
Wm. D. Lear, South Cornish.		No. 88	No. 98	No. 95	No. 85	No. 89	No. 91	No. 92	No. 90		
		390 bu.	293 bu.	273 bu.	273 bu.	231 bu.	234 bu.	234 bu.	195 bu.		
J. P. Smith, Sunapee.		No. 95	No. 92	No. 91	No. 82	No. 93	No. 86	No. 85	No. 88	No. 90	No. 89
		358.5 bu.	342.8 bu.	316.6 bu.	305.4 bu.	288.7 bu.	282.3 bu.	272.2 bu.	264.3 bu.	259.6 bu.	246.6 bu.
John Wood, Washington.	Heavy.	No. 77	No. 80	No. 1	No. 65	No. 58	No. 62	No. 75	No. 69	No. 88	No. 68
		843.6 bu.	786.5 bu.	786.5 bu.	786.5 bu.	786.5 bu.	756.2 bu.	726 bu.	695.7 bu.	695.7 bu.	695.7 bu.

Wm. D. Lear, So. Cornish.—"The potatoes you sent were planted on land that was broken in June, last year, and sowed to Hungarian, manured in the fall, and plowed in. In the spring was harrowed, and planted the first week in May. They were dug the last of August and first of September. Leonard's Favorite (44) were no good, one half scabby; also Sir William (65) of last year. The remainder will try again."

Geo. L. Deming, Cornish.—"The potatoes sent me last spring were planted on April 22 on a piece of early land sloping to the south and east. The soil was a greensward, and the only manure was applied in the hill, being horse manure, one shovelful in two or three hills, and about the usual amount of phosphate. When the potatoes came up, they were liberally dressed with ashes. I had a large growth of vines. I think I erred in using horse manure in the hill; think it better to plow it under; it also has tendency to cause scab. Of the varieties received two years ago, the White Star (72) were very

Digitized by Google

poor both years; Reeve's Rose (58), large yield, but large per cent. of small ones, very scabby; American Wonder (2), large yield, less small ones, quite scabby; Sir William (65), fair yield, less scabby."

A. W. Fairbanks, So. Cornish.—"The potatoes were planted upon a piece of ground having a southern slope, and a good clay loam. It had not been plowed for six or seven years, and without fertilization throughout this time. The fertilizer used was 800 pounds E. Frank Coe's Potato Fertilizer, on three fourths of an acre, one half in drill, and remainder broadcast. I cultivated twice and hoed once. The potatoes were very large, but rotted badly toward the last."

W. H. Howard, Grantham.—"The potatoes were planted May 18, on medium dry, gravelly soil, and were dug September 12, but the vines were dead September 1. The drouth of July seemed to hurt their growth to some extent. Think on this account they matured earlier than they would otherwise. Bovee (82), about one third small; Early Roberts (85), uniform shape, and good size; Fillbasket (86), of large size; Prolific Rose (88), hardly average size; Pride of the South (89), a light yielder, but few small; Early Michigan (90), same as (89); Algoma (91), good size and shape; Alexander Perfection (92), very large and fine shape; Burrns's No. 1 (93) about an average for size; Virgirosa (95), mostly marketable. With the exception of Fillbasket, there was little rot, about one sixth of the latter were affected."

J. P. Smith, Sunapee.—"The accompanying report of results with potatoes sent me is compiled from growing them in the common hardwood soil of this locality."

John Wood, Washington.—"My soil is deep, and rather heavy. I did not have but a very few rotten potatoes, this season, and no scab. All of the different kinds are very smooth. The bugs did not trouble me this year. I had eight feet of rows, and put two pieces in a hill. I used Coe's Fertilizer."

CULTURE

Experiments in potato culture have received the attention of this and many other experiment stations to a great extent in recent years. At present the various questions formerly in doubt are fairly well understood. Instead of going into the subject in detail, the writer has concluded to quote the summary of Farmers' Bulletin No. 35, "Potato Culture," U. S. Department of Agriculture, which covers the subject, and puts it in a very clear and condensed form, as follows:

(1) A rich, sandy loam, well drained, and well supplied with vegetable matter, is the best soil for the potato. Stiffer land may be improved as a potato soil by green manuring and drainage, and lighter soils can often be made sufficiently rich by the addition of green manures and fertilizers.

Digitized by Google

(2) Potatoes should not, as a rule, be grown continuously on the same land, but should be alternated with other crops. Barnyard manure may be freely used, but should, as a rule, be applied to previous crops in the rotation.

(3) If commercial fertilizers are used a mixture containing nitrogen in form of nitrate of soda, phosphoric acid as superphosphate, and potash as sulphate, and in which potash predominates, is recommended.

(4) Preparation of the land should be deep and thorough.

(5) Planting without ridging generally affords the larger yield, but a stiff soil and the desire for an extra early crop sometimes necessitates planting on ridges.

(6) The best time for planting depends upon the climate of each locality; the planting should be so timed as to bring the period when the tubers are rapidly forming at a date when the average rainfall is ample.

(7) On mellow, well-drained soil, deep planting (3 to 5 inches) is best, especially when the season happens to be dry. For the early crop, or on stiff soil with a tendency to bake, the depth of planting may be decreased.

(8) The use of the harrow before the plants are all up and frequent shallow cultivation afterwards until the vines shade the land are advisable.

(9) Seed potatoes grown in New England in several tests proved superior to Maryland seed both in New England and in Maryland. However, the data seem insufficient to determine definitely the relative value of seed potatoes from different climates.

(10) Cutting the seed pieces a few days before planting appears to exercise no injurious influence, provided, of course, that the cuttings are carefully stored in the interim.

(11) The yield from planting the seed or bud end is generally greater than from the stem or butt end of the tuber. The eyes on the seed end are the first to germinate, and hence are especially important when an early crop is desired.

(12) Exposing unsprouted tubers in a warm place before planting hastens growth, but if continued until sprouts form (which are rubbed off), the yield may be considerably reduced.

Digitized by Google

(13) Experiments indicate that it is more important to cut the tuber into compact pieces of nearly uniform size than to so shape the pieces as to have a definite number of eyes on each set. No piece should be entirely devoid of eyes, and the majority of the seed pieces should be large enough to support at least two eyes and better three or more.

(14) At distances of 1 by 3 feet, and with seed tubers averaging 4 ounces, an acre requires of quarters about 15 bushels.

(15) The total yield increases with every increase in the size of seed piece from the single eye to the whole potato; this increase occurs both in the large and in the small potatoes, but chiefly in the latter.

(16) The gross yield of salable potatoes (large and medium) also increases with the size of the seed piece from one eye to the whole potato.

(17) The net yield of salable potatoes (found by subtracting the amount of seed potatoes and the yield of small potatoes from the total yield) increases with every increase in the size of seed piece from one eye to the half potato. The half potato affords a larger net salable crop than the whole potato, on account of the excessive amount of seed required in planting entire tubers. Taking the average of many experiments it was found that for every 100 bushels of net salable crop grown from single eyes there were 114 bushels from 2-eye pieces, 131 bushels from quarters, and 139 bushels from halves, but only 129 bushels from planting whole potatoes.

(18) These results favor the use of halves as seed pieces if seed potatoes and crop are assumed to be of equal value per bushel, but when seed potatoes command a very high price quarters may be used to advantage.

(19) Large seed pieces afford an earlier crop and are less liable to result in a deficient stand or entire failure, which, in unfavorable years and poorly prepared soil, is sometimes the fate of small pieces.

(20) With judicious planting there is probably no necessity for reducing the number of stalks per hill by thinning.

(21) It is better to place in a hill one large piece than several very small ones of the same aggregate weight.

Digitized by Google

(22) Distance, variety, character of soil, and numerous other conditions are factors in determining the most profitable amount of seed. The distance allowed each piece should increase with the size of the piece, and should be greater with varieties with rank growth of vines and numerous tubers than for less vigorous varieties.

(23) Small potatoes can sometimes be used for seed with profit, in which case they should be planted whole. Leading growers are careful to select for seed medium to large tubers of good shape, and their example should be followed.

(24) In harvesting it pays to handle potatoes carefully, and this is especially necessary for early potatoes dug before the vines are completely dead, and while the skin is tender. Removing the largest tubers by hand, before growth ceases, does not necessarily reduce the yield, but is practicable only on small areas.

(25) Darkness and a low temperature are the primary requisites in the successful storing of potatoes.

(26) In warm climates a second crop can be obtained within one year by planting sprouted whole potatoes in midsummer.

REMARKS

1. The yield for each variety for the past season is found in Table I.

2. Table II represents the average yield of all varieties for the two potato years of 1896 and 1898.

3. The seventeen varieties giving the largest average yield, in order of productiveness, are given in Table III.

4. For cultural directions see page (70).

5. The coöperative potato tests with practical growers throughout the state have been classified into counties, and these arranged alphabetically,—Belknap page 54, Cheshire 55, Coös 57, Grafton 58, Hillsborough 62, Merrimack 64, Rockingham 66, Strafford 67, Sullivan 69.

6. No varieties for test purposes will be sent out this season.

7. The Experimental Station will be pleased to receive reports or seed thought to be of value at any time.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

H. A. ... N.
Baton Rouge, La.
No.
Rec'd

Sci 1636.35

The Forest Tent Caterpillar

BY CLARENCE M. WEED

Bulletin 64 April, 1899

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

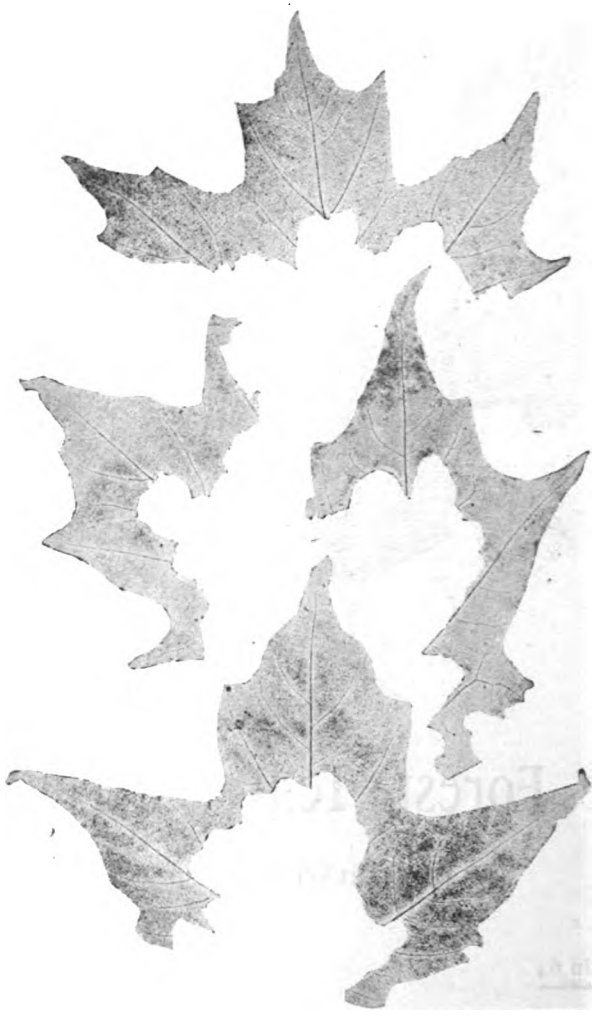


FIG. 20. Fragments of Leaves of Maple cut off by Forest Tent Caterpillars.

Digitized by Google

THE FOREST TENT CATERPILLAR

BY CLARENCE M. WEED

FIG. 21.—Egg Masses.

DURING the last three years, in many parts of New Hampshire and neighboring states, there has been a serious outbreak of the insect which has long been known as the Forest Tent Caterpillar, although in most regions where it has recently been present it is called the Forest Worm. It has attacked forest, orchard, and shade trees, and has done a great deal of damage in many regions of New England.

This is no new pest: for a century or more it has been known as a destructive insect. At frequent intervals in the past it has ravaged orchards and woodlands in widely separated states; from Maine to Texas severe attacks by it have been recorded.

These Forest Tent Caterpillars hatch from eggs which are deposited in cylindrical masses that form complete circles upon the smaller twigs of a considerable variety of trees. The appearance of these "caterpillar belts" is shown in Fig 21; the eggs are covered with a brittle substance which gives the mass a shiny appearance, especially in a bright light.

The young caterpillars or larvæ come forth from the egg in spring about the time the leaves of the trees begin to unfold. When first hatched they are tiny creatures, scarcely one-tenth of an inch long, showing under a lens that the blackish body is provided with a covering of long brownish or grayish hairs.

Digitized by Google

Wherever they go these little larvæ spin a silken thread which marks their pathway, although the thread is so slender that it is generally to be seen only through a lens.

The tiny caterpillars feed upon the tender leaves of the twig near where the egg mass was placed. In about two weeks each larva increases in size to such an extent that the skin in which it came from the egg is too small for it. This skin then splits open along the back, and the caterpillar crawls out clad in a new skin that had gradually been forming beneath the old one. This skin-shedding process is called moulting; it is the general way in which insects provide for increase in size. All sorts of caterpillars as well as other insects moult as they grow.

After the first moult the Forest Caterpillars begin feeding again, eating of course more and more of the foliage as they become larger. A week or so later they again moult, a process which is twice repeated thereafter at similar intervals. At the period of moulting the caterpillars are in the habit of congregating upon the trunks or larger limbs of the tree, often not far from the ground. Beneath the mass of larvæ there is an inconspicuous web in which the feet are more or less entangled. The appearance of the caterpillars at such times is well shown in the photograph reproduced in Fig. 24, for the use of which I am indebted to Dr. F. W. Russell, Winchendon, Massachusetts.

When the caterpillars become full grown in this, their larval state, each seeks a place in which to spin its cocoon. Many remain in the trees and tie up the leaves by silken threads, thus forming a partial or complete covering for the cocoon (Fig. 29). Others seek crevices in the rough bark, while many others—probably one-half or more of all the caterpillars—forsake the tree and wander off

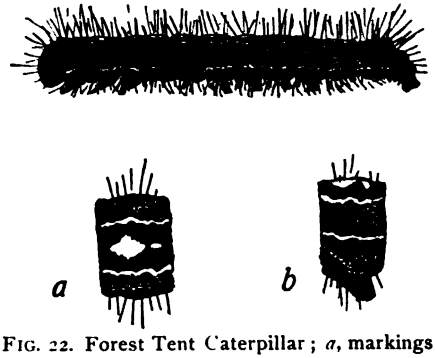


FIG. 22. Forest Tent Caterpillar; *a*, markings on one ring of the back; *b*, markings on one ring of the side.

Digitized by Google

in all directions, utilizing any shelter they may come upon. They commonly crawl up the sides of houses and other buildings, and form their cocoons along the clapboards or beneath the gables.

The cocoon is made of silk with an outer mass very loosely spun, and an inner mass so much more closely woven that it forms a web of almost parchment-like texture. As in the case of the American Tent Caterpillar, the threads of the cocoon are white when first spun, but become yellow by being saturated with a liquid which the caterpillar ejects shortly before pupation. As this liquid dries it leaves a yellow powder in the silk.

Soon after forming the cocoon around itself the caterpillar changes to the pupa or chrysalis condition, becoming an oval brown object without legs or wings, able to move only by a wriggling of its body. In this condition it takes no food, but within the quiet exterior the body of the caterpillar is being developed into that of a moth.

About ten days after the cocoon was made the pupa skin cracks open, and a brownish moth emerges from the cocoon: this is the adult condition of the Forest Caterpillar. The male moths are slightly smaller than the females, as may be seen from Figs. 23 and 25, the first of which represents the male and the second the female, both natural size.

The moths generally make their appearance the latter part of June. Soon afterwards the females deposit their eggs in masses of about two hundred each upon the twigs. The moths, having completed the cycle of life, die soon after the eggs are laid.

The eggs thus deposited early in July are to remain unhatched until the following spring. The actual formation of the tiny caterpillars from the contents of the egg takes place, however, within a few weeks after they are laid. The minute but fully-formed caterpillars may be found within the egg shells, by a careful examination, any time between September and the following April. The caterpillars remain during this long period quietly confined within

FIG. 23. Male Moth of Forest Tent Caterpillar. Natural size

Digitized by Google

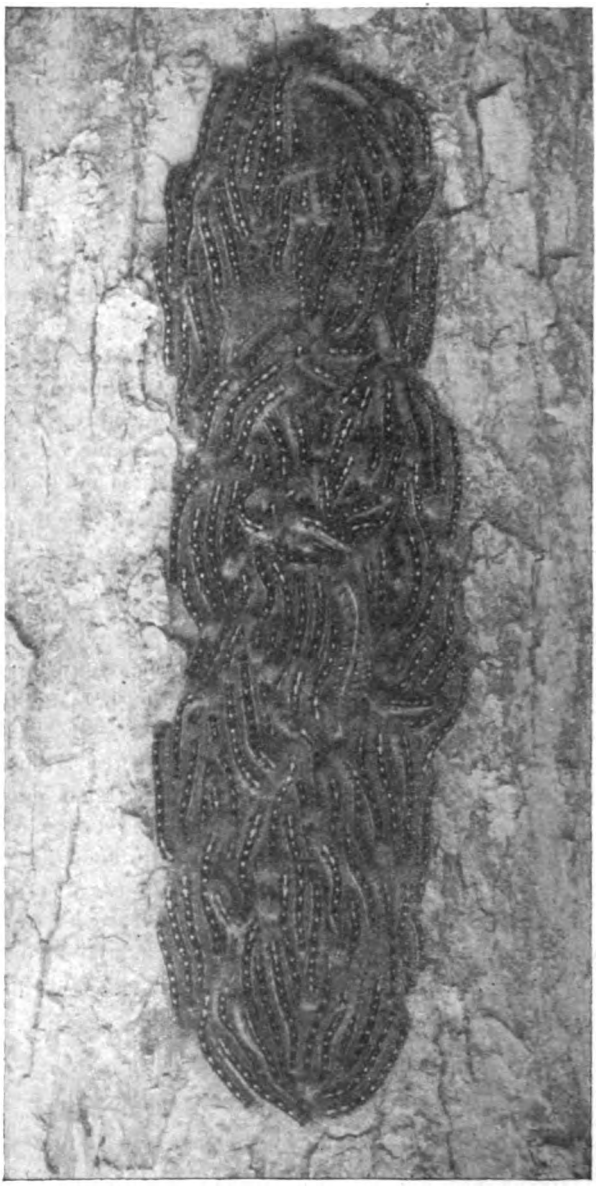


FIG. 24. A Mass of Caterpillars on the trunk of a Crab-Apple. (Photographed by Dr. F. W. Russell.)

Digitized by Google

their narrow houses, but when the warm rays of the spring sunshine penetrate their abodes, they eat off the tops of the egg-shells, and come out ready to break their long fast upon the tender foliage of the unfolding buds.

HABITS OF THE CATERPILLARS

The caterpillars very commonly emerge from the eggs some time before the leaves of their food-plants push out. Under such conditions the tiny larvæ are likely to huddle together upon or near the egg-mass to await the unfolding of the leaves. There seems to be considerable variation in the time of hatching, as larvæ of various sizes may be found at any time during the latter part of May or in June.

When the attack is not severe the caterpillars seem to keep to the upper parts of the tree, especially upon the ends of the outer branches. One correspondent in Sullivan county, New Hampshire, in sending cocoons July 29, 1897, wrote, "A very destructive pest is destroying the foliage of our maple grove. I send you a sample of the nests. There are millions of them. They seem to commence at the top of the tree and eat down. We do not see the insect at all. They seem to be hidden through the day at least."

Fig. 25. Female Moth of Forest Tent Caterpillar. Natural size.

In this instance the damage had evidently been done before the presence of the insect was known. Consequently it seems worth while for the owners of maple or other groves to keep a sharp watch upon their trees this season, even if heretofore they have not been injured.

When the caterpillars are disturbed while feeding upon the leaves or crawling along the twigs they have a habit of dropping downward, checking the fall by means of a thread spun from the mouth and attached to the twig. Thus suspended in mid-air they are very annoying to foot-passengers in villages or to people riding along shaded roads in town or country; for to find yourself suddenly confronted by a dozen caterpillars on the level of your face is disconcerting.

Digitized by Google

FIG. 26. Elm Leaves partially eaten by Forest Tent Caterpillars.

Digitized by Google

According to some observations made by my assistant, Mr. W. F. Fiske, to whom I am indebted for a number of observations upon this insect, the young caterpillars if suddenly disturbed while feeding will drop to the ground without attaching their threads. A large proportion of the caterpillars drop off by means of a thread at one time or another during their growth: some are probably startled by the swaying of the twig in the wind; others by birds when alighting; in many cases the movement is probably induced by the exhaustion of the food supply, or, perhaps, by a migratory instinct. In any event, this dropping is very general, and as a result the caterpillars are continually to be seen crawling up the trunks of the trees; this is especially likely to be the case early in the morning.

The larvæ generally crawl along the limbs in single file. As they go, each spins from its mouth a delicate silken thread.

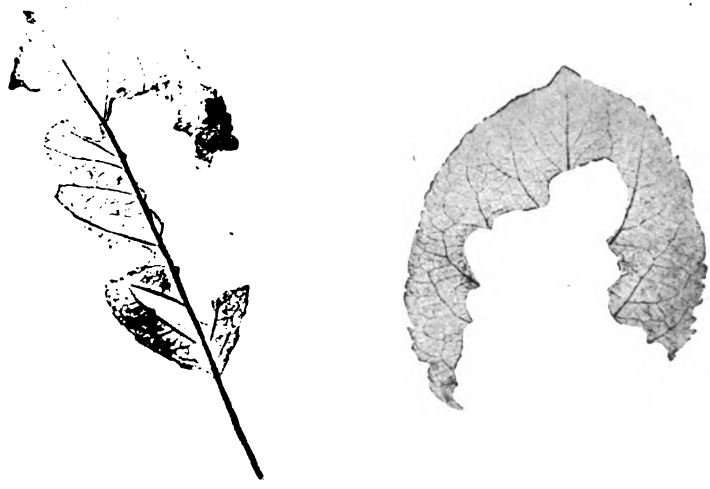


FIG. 27. Apple leaves partially eaten by Forest Tent Caterpillars.

When not eating, they congregate in masses upon the larger limbs, with an indistinct web beneath them, although generally there is no web over them, as is the case with the American Tent Caterpillar.

In feeding, especially as they approach maturity, the cater-

Digitized by Google

pillars commonly eat through the leaf in such a way that the outer end drops to the ground. Examples of this sort of injury are shown in Figs. 20, 26, and 27. The result is that in the case of the badly-infested trees the ground beneath is covered with these leaf fragments, which may be heard falling continually as the caterpillars work. This habit causes the insect to be relatively much more destructive than if it simply devoured the whole leaf because the tree is robbed of more of its leaf-surface, the damage done being somewhat analogous to that of the cutworms, which eat off the stem of a corn plant without devouring the leaves.

During the moulting periods, as well as during long-continued storms, the caterpillars collect together in great masses, resting upon a silken web attached to the bark of the tree. (Fig. 24.) Here they remain a day or two, until the old skins are sloughed off and the new ones are ready for use.

The caterpillar of this species is at once distinguished from the common American Tent Caterpillar by the differences in the markings of the line along the middle of the back. In the Forest Tent Caterpillar this line is interrupted, consisting of a series of white markings like that shown in the middle of Fig. 22, *a*, while in the common Tent Caterpillar the line along the middle of the back is continuous. (Fig. 28, *a*.)

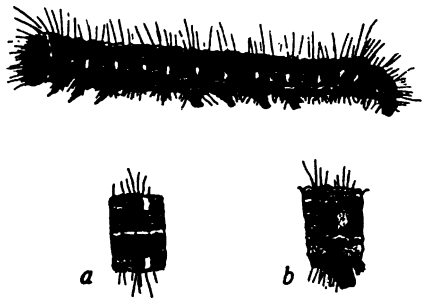


FIG. 28. American Tent Caterpillar; *a*, markings on one ring of the back; *b*, markings on one ring of the side.

The two species of caterpillars may frequently be found intermingled. Sometimes a brood of the Forest species will collect upon the outside of the tent of the common species.

When an orchard or grove in which the caterpillars have developed is defoliated, they will migrate to neighboring trees in a way suggestive of the migrations of the Army Worm.

At such times they may be seen in incredible numbers.

Digitized by Google

Several cases are on record where in crossing railway tracks they have impeded the progress of trains by making the rails slippery as the bodies were crushed. One case which has been vouched for by the entomologists of the United States Department of Agriculture, after official investigation, is reported in these words:

"The rails on the Carolina Central railroad were covered inches deep with caterpillars, so that for three days in succession trains were brought to a dead standstill, the driving-wheels of the engine slipping round as though the rails had been thoroughly oiled. The engineers were obliged to exhaust the contents of the sand boxes before crossing the strip of swamp from which the caterpillars seemed to come. The rails and cross ties were said to be obscured from sight, and the ground and swamps on each side of the track were covered with millions of the crushed caterpillars, and from the mass an unendurable stench arose." *

Those Forest Caterpillars which utilize leaves in forming their cocoons seem to have very little choice as to the leaves employed. In Vermont, Miss Caroline G. Soule, to whom I am indebted for a large number of observations upon this insect, found cocoons made in the leaves of the following plants:

Apple	Hawthorn
Asparagus	Horse Chestnut
Barberry	Hydrangea
Cherry	Maple
Clover	Mountain Ash
Cut-leaved Birch	Lilac
Elm	Pear
Ferns	Plum
Fountain Plant	Smoke Tree
Fringe Tree	Syringa
Geranium	Violet
Grape	Woodbine
Grass	

Probably this list could be considerably increased by more

* Insect Life, Vol. iii, p. 477.

Digitized by Google

extended observations in other localities. Evidently the larvæ utilize whatever foliage they find available when the stress of cocoon making is upon them. A correspondent at Haverhill, New Hampshire, reported that she found "pine trees covered with the cocoons of the Forest Tent Caterpillar. The needles were tied together with their silk, and the cocoons inside of them." These leaf coverings are of all degrees of perfection from such a well-knit specimen as is shown in Fig. 29 to that of a cocoon in which two or three grass blades serve little more purpose than that of supporting the silken woof of the cocoon. Two or more cocoons are commonly spun within a single leaf, and trees frequently appear "bunched up" from the action of the caterpillars. Numerous observations indicate that normally about as many caterpillars spin cocoons in leaves as out, but the proportion would be likely to vary with the conditions present in a given locality.

FIG. 29. Cocoon of Forest Tent Caterpillar in a maple leaf. Natural size.

FOOD PLANTS

This Forest Tent Caterpillar is a very general feeder, attacking many more kinds of plants than does the American Tent Caterpillar. In the various articles which have heretofore been published the following food-plants are recorded:

Apple	Oak
Ash	Peach
Beech	Plum
Birch	Poplar
Cherry (wild and cultivated)	Rose
Hawthorn	Sour Gum
Hickory	Sweet Gum
Linden	Walnut
Maple	

Digitized by Google

During June, 1898, Miss Soule observed these caterpillars in the vicinity of Brandon, Vermont, feeding upon the following species:

Apple	Purple Beech
Barberry	Rose
Cherry (wild and cultivated)	Smoke Tree
Currant	Horse Chestnut
Diervilla	Linden
Elm	Lilac
Fringe Tree	Locust
Hawthorn	Magnolia
Mountain Ash	Swamp Fly Honeysuckle
Pea Vines	Willow
Pear	Woodbine
Peonies	White Birch
Plum	

The caterpillars have also been abundant upon oak, poplar, and various other trees.

HABITS OF THE MOTHS

Like most moths the adults of these Forest Caterpillars are night-fliers rather than day-fliers. They are attracted by light after dark, and frequently fly through open windows into houses. Late in the afternoon they may also be seen when abundant, flying among the branches of the trees.

I have not seen the moth while depositing the eggs, but the process has been described by Dr. C. V. Riley as follows: "These eggs are deposited in circles, the female moth stationing herself for this purpose, in a transverse position across the twig. With abdomen curved, she gradually moves as the deposition goes on, and when one circle is completed she commences another, and not before. With each egg is secreted a brown varnish, which firmly fastens it to the twig and to its neighbor, and which, upon becoming dry, forms a carinated net-work of brown over the pale egg-shell. These eggs are so regularly laid and so closely glued to each other, and the sides are often so appressed, that the moth economizes space

Digitized by Google

almost as effectually as does the honey-bee in the formation of its hexagonal cells."

ABUNDANCE AND INJURIES

The injuries caused by these caterpillars have been serious and widespread. In many regions they have defoliated the maples of sugar groves. In some cases the trees have been killed, while in others their vitality has been so weakened that they became, at least temporarily, of little value for sugar production. When syrup is made from such trees, it is of such inferior quality that it is often locally called "buggy syrup." All through the infested regions hillsides may be seen in which the woods are brown and bare from the attacks of the caterpillars.

It is difficult for one who has not seen an outbreak of such a pest as the Forest Caterpillar to get an adequate conception of the enormous numbers which may be present. They have been collected, quarts at a time, in many localities, and are often so abundant on the trunks of trees as to conceal the bark from view. An idea of the mass which may migrate from one place to another may be obtained from the account already given of their stopping railroad trains (p. 85).

The effect of a sudden onslaught of an army of these caterpillars migrating from a neighboring woodland to an apple orchard may be disastrous. Defoliation may take place in so short a time that the leaves are gone before the presence of the caterpillars is known. In many cases a new crop of leaves will be put out, but the vitality of the trees is necessarily impaired.

DATES OF TRANSFORMATIONS

The statement has already been made that there is considerable variation in the time of hatching of the caterpillars. By the middle of June, when some of the larvæ had become full-grown and spun cocoons, others had only moulted once, and many others only twice. The majority of the caterpillars spun up by June 25, and practically all by the 30th of the same month. Many of these caterpillars which spun latest were much smaller than the normal size. The earliest moths emerged about June 24.

Digitized by Google

DESCRIPTION OF THE LIFE STAGES

Egg. — The egg mass of this Forest Caterpillar is in the form of a belt encircling the smaller twigs of the various food-plants. Its general shape is represented in Fig. 21, the length of the belt varying from one-fourth to one-half of an inch; the diameter is usually one-fourth of an inch. The belt terminates abruptly at each end, although it is not as a rule squared off. The outside of the belt consists of a glistening, varnish-like, brownish or lead-gray material, which covers the eggs. When the eggs are first laid, and for some months afterward, this covering remains entire, but as the winter passes, it becomes more and more broken, so that by spring it generally has a rather ragged appearance. By removing the covering, the eggs will be found beneath, resting side by side at right angles to the supporting twig. Each egg is a trifle longer than wide, and is covered with a reticulated net-work of the same varnish-like material that conceals the mass as a whole: this net-work serves to attach the eggs to the twig and to each other. The eggs are of a dull gray color, showing white in some places. When the caterpillars hatch they gnaw off a circular cap on the upper end of the egg, and come out through the hole thus made. Each egg is about one-twentieth of an inch long. The number of eggs in one belt varies from less than 150 to more than 225, the average being nearly 200.

Larva.—The full-grown Forest Tent Caterpillar has a cylindrical body about two inches long and a little more than a quarter of an inch thick. It is rather sparsely clothed with brownish hairs. The general color is bluish. Along the middle of the back there is a series of double whitish or cream-colored spots having the appearance of Fig. 22, *a*. By means of these spots the caterpillar may easily be distinguished from the common American Tent Caterpillar; in the latter species the line along the middle of the back is continuous (Fig. 28, *a*). On the upper part of each side of the Forest Caterpillar there runs a rather broad blue line, edged above and below with a narrow, yellowish-brown line. The head is bluish. Near the front end of the body are three pairs of jointed legs, each with a

Digitized by Google

hook-like claw at the tip. Along the middle of the body are four pairs of thicker prolegs, and at the hind end is another pair of prolegs.

Pupa.—The pupa when removed from the cocoon is a brownish object without legs or wings or other external organs. It is about three-fourths of an inch long by one-fourth broad at its widest part, although the male pupa is noticeably smaller than that of the female.

Moths.—An idea of the general appearance of the moths may be obtained from Fig. 23 which represents the male, and Fig. 25 which represents the female, both natural size. As will be seen the former is the smaller. The general color is a buff brown with an oblique band of a deeper tint across each front wing. The "feelers" or antennæ of both sexes are feathery, those of the male being the broader.

NAMES

The accepted scientific name of this species is *Clisiocampa disstria*, although it was formerly called *C. sylvatica*. Its common name, Forest Tent Caterpillar, is not very satisfactory, because, first, the insects are as likely to be found in apple orchards as in forests, and, second, they do not make tents in the complete sense that the nearly-related American Tent Caterpillar does. But the insect has always been called the Forest Tent Caterpillar in our literature, and the name may as well be retained until one more satisfactory is suggested.

Many people have been needlessly alarmed by the thought that this was the famous Gypsy Moth Caterpillar. It has nothing to do with that notorious insect, although it may well serve as an illustration of what would be likely to take place if the Gypsy Moth should become widespread.

NATURAL ENEMIES

These Forest Tent Caterpillars are preyed upon by many natural enemies, including insects, spiders, toads, and birds. Among the more important insect enemies are certain ichneumon flies, similar to Fig. 30, which deposit eggs within the bodies of the caterpillars. These eggs hatch into grubs that

Digitized by Google

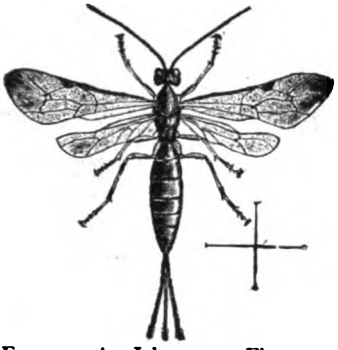


FIG. 30.—An Ichneumon Fly, magnified.

develop at the expense of the caterpillars, finally killing them. There are various other insect enemies.

A curious habit of a common species of Harvest-spider, or Daddy-long-legs, was observed by Miss Soule. On June 18 she wrote: "On almost every mat of Clisiocampa larvæ we find several 'daddy-long-legs,' sometimes as many as twenty. I have watched them closely and can see no reason for their being there." A week later she wrote again: "It seems this morning as if almost every larva was attended by a 'harvester,' which apparently stroked it with a leg or two or merely stood near or over it. Sometimes the touch made the larva curl up, but more often it seemed to have no effect. It is very curious, and I watch and watch but can learn nothing." The species concerned seemed to be the common Striped Harvest-spider,* as I judged from some half-grown specimens sent by Miss Soule. As to the reason for their presence I can only conjecture that they found food in connection with the caterpillars in some way.

Toads were seen to devour many of the caterpillars, although of course these creatures are comparatively so rare that they could make little impression upon the pests.

Birds, however, did a great deal toward reducing the numbers of the insects. Miss Soule observed robins, orioles, chipping sparrows (Fig. 32), cat birds, cuckoos, the red-eyed, white-eyed,

FIG. 31. The Chickadee.

* *Litbunum dorsatum.*

Digitized by Google

and warbling vireos, cedar birds, and nuthatches feeding upon the caterpillars. The nuthatches, according to Miss Soule's account, "would stand by a patch of larvæ lying close together below a tar band on a tree and eat so voraciously and with such an entire abandonment of self-consciousness that I could go close and put my hand on them before they would fly. This experience was repeated several times." The cocoons were attacked by chickadees (Fig. 31), which tore open the cocoons and fed upon the pupæ, as well as by nuthatches. The moths were also eaten in great numbers by many sorts of birds, including robins, chipping sparrows, yellow birds, and even English sparrows, although this last-named species apparently did not eat the caterpillars.

FIG. 32. The Chipping Sparrow.

In some localities the Forest Tent Caterpillars were attacked by what appeared to be a bacterial disease similar to the one which destroyed so many of the American Tent Caterpillars in southern New Hampshire in the summer of 1898. (See Bulletin 59, p. 202.) It is to be hoped that the present season it may complete its work, for this is probably the agency that is most likely to check the outbreak. Its destructive effect is likely to be increased by weakness in the caterpillars, due to the partial exhaustion of the food supply. There was also evidence that a fungus disease called "muscardine" was at work among them.

REMEDIAL MEASURES

Many remedial measures have been proposed at various times to prevent the injuries of the Forest Tent Caterpillar.

Digitized by Google

The practical value of most of these measures depends largely upon the conditions under which they are to be applied. A suggestion that is easily applicable to a few small trees in an apple orchard may be wholly inapplicable to the large trees in a woodland.

The abundance of the caterpillars, the nature and number of the trees infested, the season of the year, and the means at hand are all to be taken into consideration. In the following paragraphs I have summarized the measures which a careful study of the subject leads me to think will prove of value. They are arranged according to stage of growth—from egg to moth—to which they are to be applied.

Egg Destruction.—On a bright day, when the trees are bare of leaves, the egg-masses may be easily seen. The cutting off and burning of these masses is often practicable in a young apple orchard, although it is generally considered impracticable in orchards of large trees. It generally would be out of the question in woodlands, of course, although in case of a few ornamental maples or other trees on the home grounds, such egg-collecting might well be worth while. The gathering may be done by sending a sharp-eyed boy into the trees to cut off the glistening masses, or by means of a pruning-hook or a pair of long-handled pruning-shears. The belts of eggs should be burned after they are gathered.

Killing the Young Caterpillars.—On small trees, where the caterpillars are easily reached, something may be accomplished by swabbing the colonies of young larvæ when at rest by means of a bunch of cotton waste, old rags, or something similar. In rainy weather, one is more likely to find the larvæ massed together during the day than in bright weather.

Spraying with Poisons.—For the apple orchards, so far as concerns the caterpillars which hatch there, perhaps the simplest way of destroying these pests is to spray the trees with arsenites early in the season, before the caterpillars are half grown. After the leaves are unfolded and the caterpillars have begun work, the earlier this spraying is done the better, except that it should not take place when the trees are in bloom. The common practice in spraying is to add four or

Digitized by Google

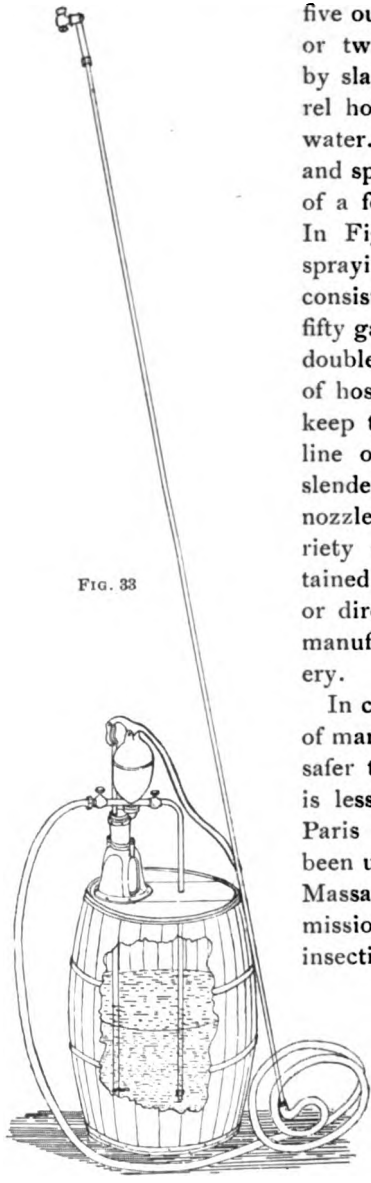


FIG. 33

five ounces of Paris green and a pint or two of fresh lime-water—made by slaking lime in water—to a barrel holding forty or fifty gallons of water. This is thoroughly mixed and sprayed upon the trees by means of a force pump and spray nozzle. In Fig. 33 a simple and effective spraying outfit is represented. It consists of a kerosene barrel holding fifty gallons, a force pump having a double discharge, with a short line of hose running into the barrel to keep the liquid stirred, and a long line of hose fitted at the end to a slender brass rod tipped with a spray nozzle. This outfit, or a great variety of similar ones, may be obtained through any hardware dealer or direct from any of the numerous manufacturers of spraying machinery.

In case it is desired to spray trees of many sorts, it would probably be safer to use arsenate of lead, which is less liable to injure foliage than Paris green. This substance has been used in great quantities by the Massachusetts Gypsy Moth Commission. It has been found a safe insecticide for all sorts of trees. It is not generally on sale in the market, but can be made according to the following directions of Professor C. H. Fernald:

"Arsenate of lead is easily prepared by putting 11

Digitized by Google

ounces of acetate of lead in 4 quarts of water, in a wooden (not metal) pail, and 4 ounces of arsenate of soda (50 per cent.) in 2 quarts of water, in another wooden pail, and when entirely dissolved mixing them in a hogshead containing 150 gallons of water, when a chemical reaction will take place, forming arsenate of lead as a fine white powder in suspension in the water. If cold water be used in the wooden pails, the solution of the acetate of lead will require a little time; but, however, if the water be hot, it will dissolve very quickly. It is customary to add from 2 to 4 quarts of glucose to the above amount of water. If it is desired to use larger proportions of the arsenate of lead, it is only necessary to use more acetate of lead and arsenate of soda, but in the proportions given above."

Another substance which has lately been put upon the market as a substitute for Paris green, is called Green Arsenite. It is a finer powder than Paris green and generally costs at retail, 15 cents a pound. It can be purchased of dealers generally, or direct of the manufacturers—the Adler Color and Chemical Company, New York. One great advantage it has over Paris green, is that being a finer powder it remains in suspension much longer. A little lime water should be added to the mixture as in the case of Paris green. It is to be used at the rate of four or five ounces to fifty gallons of water.

Killing the Older Caterpillars.—After the caterpillars are half-grown they commonly come down to the lower branches or the trunk to undergo the moulting process. To this end they gather in great masses on the bark, where they may be destroyed by means of a stiff broom—more effective perhaps if frequently dipped in kerosene,—or by collecting the caterpillars in pails containing a little kerosene and water. In the towns and villages throughout the infested regions vast numbers of the pests were destroyed in these ways, especially the latter, in 1898.

Banding.—The fact that so large a proportion of the caterpillars drop off the trees from time to time and return by crawling up the trunks, has led to the quite general use of bands of various materials upon the trunk to prevent the ascent of the larvæ. Tar has been quite generally applied for this purpose, but it is objectionable as it does not remain effective long, so

Digitized by Google

that the caterpillars are soon able to cross over it. Sticky fly-paper—"Tanglefoot"—has been commonly used with a large degree of success; it is effective, cheap, and easily applied. Rather wide bands of it are necessary to prevent bridging over by the dead or dying caterpillars. The chief difficulty with this paper is its liability to injury by rain, the wetness causing it to tear so readily that it may not last long. In some cases bands of greased tin have been successfully employed.

A better substance than any of these, however, is Raupenleim or "Caterpillar-lime," a material manufactured in Germany for application to the bark of trees to prevent the ascent of caterpillars and other crawling insects. It is to be put on as a rather wide band, or as two narrower bands. In the case of large trees with thick bark the material may be smeared directly upon the bark, while in the case of young trees and those with smooth bark it is safer to apply the Raupenleim by smearing it upon a band of heavy wrapping paper or some other thick and firm paper tacked upon the tree. Any loose bark may be scraped off the portion of the trunk which is to be covered by the paper before the latter is put on; and it is sometimes worth while to insert a thin layer of cotton waste, or some similar material, beneath the paper to fill up crevices and thus prevent any insect from crawling through beneath the paper. Then the Raupenleim may be smeared upon the paper the thickness of about a quarter of an inch, and left as long as it remains sufficiently sticky to entrap any insect that attempts to crawl over it. As it will remain eight or ten weeks in a sticky condition, a single application early in the season will probably last until danger from the caterpillars is past.

It should be distinctly understood that there may be danger of injuring trees with smooth and thin bark if this Raupenleim is smeared directly upon the bark. For young trees and those older which have a smooth bark I recommend that the Raupenleim be applied by placing it upon strips of thick paper tacked to the trunks of the trees. Even in the case of bearing apple trees this would probably be the safer method, and it should always be adopted for peach trees, if not for pear trees also. After the Raupenleim has been on some weeks the sur-

Digitized by Google

face hardens into a crust, and it is advisable to scrape off this crust after the danger from caterpillars is past. Too much of the rough bark should not be scraped off of the older trees to which the band of Raupenleim is to be applied, unless paper is to be used.

After the trees are thus banded, the caterpillars will collect beneath the bands, and, of course, are to be killed by means of a stiff broom, or any other method one may choose.

The American distributers of Raupenleim are William Menzel & Co., 64 Broad St., New York, N. Y. In New England it can be purchased through the Bowker Fertilizer Co., Boston, Mass., and probably other dealers. It is put up in five-pound cans, costing about $1.00 per can; or in kegs holding 25 pounds, costing $3.75 per keg. Larger kegs are proportionately cheaper.

Jarring and Banding.—It has already been stated that these caterpillars drop downward when disturbed, breaking the fall by means of a thread spun from the mouth; although when young and suddenly jarred apparently the thread may not be used. This habit leads to the suggestion that by a combination of jarring and banding much injury may be prevented, at least in the apple orchard and on the home grounds. After the trees infested have been banded with the caterpillar lime, a boy with a padded mallet may be sent into them with instructions to jar the limbs on which the caterpillars are working, beginning at the top. This should be done when the caterpillars are feeding upon the leaves as they are then much more easily disturbed than when they are at rest. Of course it is not to be expected that going over once will wholly rid the tree, but by two or three repetitions of the jarring most of the caterpillars should be removed. In case they hang too persistently by their threads many of them may be swept out of the air by use of a long, light pole. This will lead the caterpillars to congregate in masses upon the trunk below the bands of Raupenleim, where they may be destroyed by use of a stiff broom or by various other methods. The earlier this is done after the larvæ are all hatched the less will be the injury to the foliage.

The masses of caterpillars beneath the bands are sometimes

Digitized by Google

killed by pouring on kerosene. If this method is employed great care should be taken not to add enough to saturate the bark. Many trees have been killed by carelessness in such use of kerosene.

Banding to Prevent Invasion.—In case of an uninfested apple orchard in the vicinity of an infested woodland, it will be advisable to band the apple trees with Raupenleim before the caterpillars are half grown to prevent invasion from them. The same advice would hold in case of other uninfested trees in the vicinity of those infested.

Collecting Cocoons.—A large proportion of the cocoons are commonly spun where they can be reached. The destruction of these will lessen the number of moths that lay eggs for the next season's brood of caterpillars, although it will also lead to the destruction of large numbers of parasites. If the cocoons were placed in a good-sized box with coarse-meshed mosquito netting over it the escape of the moths might be prevented while the parasites might get away to continue their good work. By a little trouble the moths remaining in the box could be killed.

Attracting Moths to Light. Like many other night-flying insects the moths of the Forest Tent Caterpillar are attracted to lights at night. This has led to the suggestion that they may be destroyed by placing a lighted lantern over a tub or other wide vessel containing water with a film of kerosene on top. The moths fluttering about the light will fall into the kerosene and be killed. Such destruction will lessen the number of eggs for next year's brood of caterpillars.

Digitized by Google

return to H. ... File

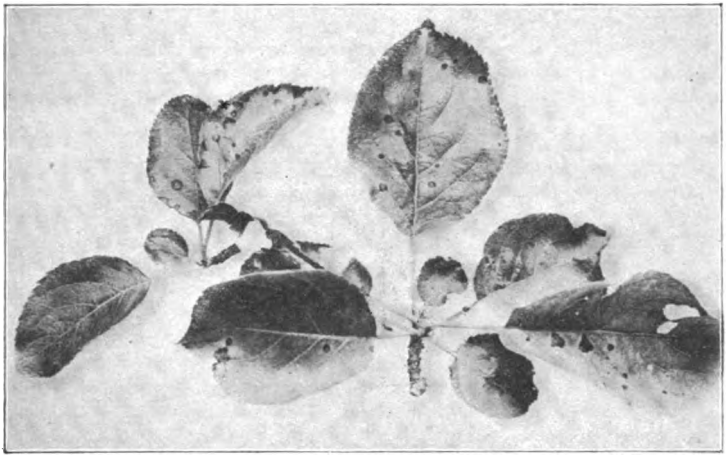
Bulletin 65 May, 1899

NATURAL HISTORY LIBRARY
Sci 1636.35

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

Notes on Apple and Potato Diseases



LEAF SPOT OF APPLE

BY H. H. LAMSON

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

Digitized by Google

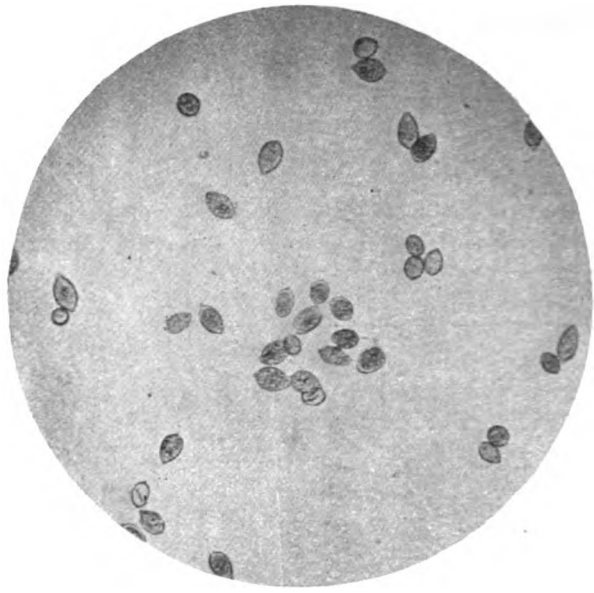


FIG. 35.—Spores of Late Potato Blight. Magnified.

FIG. 36.—Spraying Potatoes.

Digitized by Google

Notes on Apple and Potato Diseases in 1898

BY H. H. LAMSON

The principal fungous diseases of the potato are the *scab*, the *early blight*, and the *late blight*. Each of these is due to a minute parasitic plant which finds in the potato a congenial host plant, and develops on it to its serious damage. The *scab* attacks the tubers, the *early blight* the leaves, and the *late blight* all parts of the plant producing in the tubers the disease known as *potato rot*. Each of these diseases is propagated by means of spores or germs which bear the same relation to the fungous plant that seeds do to the higher plants.

POTATO SCAB

This disease affects the surface of the tubers, producing the familiar scabby or scurfy appearance. The crop is infected either by germs on the seed planted or by germs already present in the soil derived from a previous crop. These facts lead to the following practical suggestions as to treatment of the disease: Plant seed known to be free from scab or seed which has been freed from living germs by some method of disinfection; do not plant on ground from which a scabby crop has previously been taken.

Since under ordinary circumstances it is difficult to obtain seed entirely free from scab germs, some method of disinfection becomes an important consideration. Three substances in particular have been recommended for this purpose, corrosive sublimate, formaline, and sulphur.

Corrosive Sublimate.—In previous bulletins of this Station experiments have been described in which this substance was used with profitable results. The following additional experi-

Digitized by Google

ments are here reported. In these experiments the potatoes were planted on ground which had probably not been used for this crop for many years at least. The seed potatoes selected were badly scabbed. Part of the seed was planted untreated; the other part was treated with corrosive sublimate in the manner to be described later. Treated and untreated seed was planted in plots side by side, under similar conditions of soil and fertilzation. When the potatoes were harvested the untreated plots in field A, gave 48 per cent. scabby, and 52 per cent. free from scab; the treated plots gave 17 per cent. scabby, and 83 per cent. free from scab; a gain of 31 per cent. in favor of the treatment.

A similar experiment in another field (field B) gave from untreated seed 35 per cent. scabby and 65 per cent. free; from treated seed, 13 per cent. scabby and 87 per cent. free, or a gain of 22 per cent. in favor of the treatment.

Method of Using Corrosive Sublimate.—Dissolve corrosive sublimate in water at the rate of one ounce to eight gallons of water. Keep this solution in a wooden vessel; a barrel, half barrel, or washtub will answer the purpose. Put the potatoes to be treated in a coarse sacking bag, and plunge in the solution; let them remain for an hour and a half, moving them about occasionally to insure thorough wetting; then dry the potatoes, and they are ready for planting. Care should be taken that they do not become contaminated again by dirt from untreated potatoes. It should be remembered that corrosive sublimate is a violent poison if taken internally, therefore care should be taken in using it.

Formaline.—This is a liquid which has recently come into prominence as a valuable disinfectant. It is sold under various names, "Formalin," "Formine," "Formalose," "Formaldehyde," and is usually a 40 per cent. solution of formaldehyde gas in water.

In our experiments with this substance as a remedy for potato scab two strengths were used, viz.: One pint to 32 gallons of water, and one pint to 21 gallons of water. The potatoes were soaked in these solutions for two hours. They were planted alongside the corrosive sublimate plots in field A, and under the same conditions, the same untreated plots serving as checks

Digitized by Google

for both. As above, the untreated plots gave 48 per cent. of scabby potatoes and 52 per cent. scab-free. The plots treated with the stronger solution of formaline gave 13 per cent. scabby and 87 per cent. scab-free; a gain of 35 per cent. in favor of the treatment. The plots treated with the weaker solution gave scabby, 21 per cent., scab-free, 79 per cent.; a gain of 27 per cent. in favor of the treatment. These results indicate that formaline is an effective remedy for the scab, and in the strengths used above rivaling corrosive sublimate. It possesses advantages over corrosive sublimate in being less poisonous and more easily applied, but with the data at hand we are not yet ready to recommend its substitution for that remedy.

Influence of Different Fertilizers on Development of Scab.—The following table summarizes the results of experiments in regard to this point. The experiments with different fertilizers were crossed with those on the treatment of the scab on the same plots.

		Field A.		Field B.		Previously reported.	
		Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Phosphate.....	Scab free.....	83	53	79	89	92	63
	Scabby.....	17	47	21	11	8	37
Stable manure...	Scab free.....			80	60	97	86
	Scabby.....			20	40	3	14
Plaster.....	Scab free.....					88	44
	Scabby.....					12	56
Air slaked lime..	Scab free.....	89	47	100	58		
	Scabby.....	11	53	0	42		
Wood ashes.....	Scab free.....	70	34	95	28	90	59
	Scabby.....	30	66	5	72	10	41
No fertilizer.....	Scab free.....	90	73	95	81		
	Scabby.....	10	27	5	19		

Digitized by Google

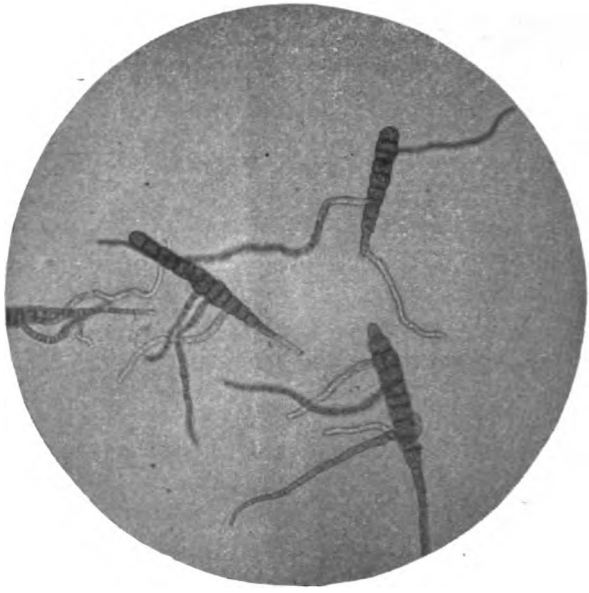


FIG. 37.—Germinating Spores of Early Blight. Magnified.

From these not wholly concordant results we prefer rather to point out indications than to draw final conclusions.

The indications are that, first, all of the fertilizers named may favor the development of the scab to a greater or less degree; hence as fertilizers cannot be dispensed with, the greater advisability of treating the seed. Second, air-slaked lime, plaster, and ashes are especially likely to increase the amount of scab.

POTATO BLIGHTS OR "RUSTS"

As indicated above there are two forms of "*blight*" or "*rust*," the *early* and the *late*. There is usually little difficulty in distinguishing between the two. The *early blight* appears in June or July, the *late* in August. The *early blight* presents numerous sharply-outlined, dark brown spots on the leaves; the *late* blight manifests itself as a progressive withering or dying of the leaves, spreads more rapidly than the *early*, and usually presents a readily seen white mold-like growth on the under side of the leaves. Both diseases often appear together, especially on late varieties. Both of these diseases are spread

Digitized by Google

by spores. Fig. 37 shows the curiously shaped spores of the *early blight* germinating preparatory to infecting the host plant. Fig. 35 shows the egg-shaped spores of the *late blight.*

Repeated experiments have shown that both these diseases may be profitably controlled by spraying with the Bordeaux mixture.

When to Spray.—For *early blight* on early potatoes, spray when the vines are about two thirds grown or as soon as the disease makes its appearance; repeat the spraying in about two weeks.

For both *early* and *late blight* on late potatoes spray three times; the middle of July, the first of August, and the middle of August.

Rainy weather may render it advisable to spray at shorter intervals and to increase the number of sprayings.

Spraying Outfit.—Fig. 36 shows a convenient outfit for potatoes or fruit trees; a pump specially designed for spraying mounted on a barrel of about 50 gallons capacity drawn on a wagon with one man to pump and another to apply the spray. In spraying potatoes a liberal length of hose should be used; we use fifty feet or more. A farmer naturally hesitates to drive over a field of thrifty "tops," but the injury is hardly to be considered as against the benefit of spraying. With a good length of hose the necessity of driving over the field is reduced to a minimum.

Effect of Bordeaux Mixture on Insect Injuries.—In this regard the following is of interest. A field was sprayed three times with Bordeaux mixture, a strip across the rows on one side was left unsprayed as a check. Between the first and second sprayings the unsprayed vines died. No fungous trouble could be detected, nor were the "slugs" of the Colorado beetle present, although many of the mature beetles were. The *flea beetle*, however, was present and was probably the chief cause of the destruction of the vines. The sprayed vines lived. A strip of the sprayed potatoes of the same area as the unsprayed and lying next to it yielded a little more than three times as many marketable potatoes. Bordeaux mixture is probably one of the best remedies against the flea beetle. (See Bulletin 29 of this Station.)

Digitized by Google

APPLE DISEASES

Spraying experiments on apples during the season of 1898 were not made with reference to any particular disease, but against any disease that might make its appearance. The trees sprayed were mostly Baldwins. The diseases which developed were those shown in Fig. 38, characterized by small brown

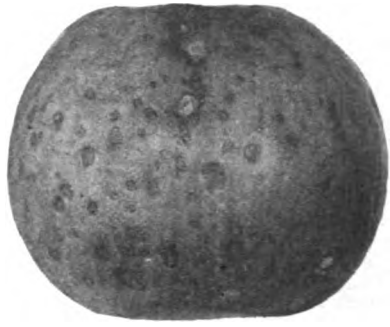


FIG. 38.—Brown Spot of Baldwin.

spots on the surface of the fruit; in Fig. 39, characterized by black or sooty diffuse blotches of no appreciable thickness, also on the fruit; and in figure on title page, characterized by small, round, reddish-brown spots on the leaves. The latter disease, which is caused partly at least by *Phyllosticta pirini*, in some cases does quite serious damage. The two other diseases seem to injure the fruit chiefly by rendering it unsightly.

The trees were sprayed three times with 1 to 10 Bordeaux mixture once before blossoming, again just after the fall of the petals, and a third time about two weeks later. Paris green was added to the mixture at the second spraying for the codling moth.

The following table shows the results:

		Nearly or quite free from spots.	Spotted.	Badly spotted.
Brown spot on Baldwin,	Unsprayed,	48 per cent.	44 per cent.	8 per cent.
	Sprayed,	78 "	18 "	4 "
Sooty spot on Baldwin,	Unsprayed,	17 "	63 "	20 "
	Sprayed,	83 "	14 "	3 "
Sooty spot on Greening,	Unsprayed,	18 "	57 "	25 "
	Sprayed,	77 "	23 "	0 "

Digitized by Google

The Greening seems to be free from the brown spot but is very apt to be disfigured by the sooty spot.

Brown Spot of the Foliage.—In all of our spraying experiments during the past four or five years, the Bordeaux mixture has appeared to have but little if any effect upon this disease.

Apple Scab.—This disease has done but little damage to Baldwins in this part of the state at least for three or four years.

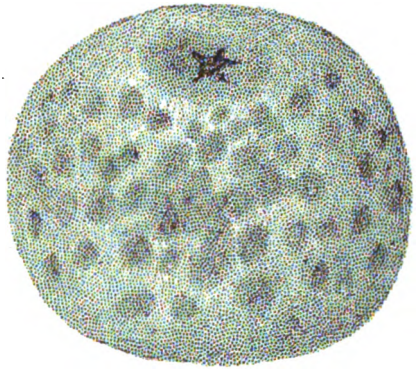


FIG. 39.—Sooty Spot of Apple.

When it does make its appearance on this or other varieties it readily yields to Bordeaux mixture. The same is true of the *scab* and *cracking* of pears.

When to Spray for the Fungous Diseases of the Apple and Pear.—Spray once before the blossoms open, again as soon as the petals fall, and a third time two weeks later. As in case of potato diseases the number of sprayings may have to be increased in rainy weather.

BORDEAUX MIXTURE

The Bordeaux mixture continues to recommend itself as the best all-round remedy for fungous diseases. It is efficient, it is cheap, and it is easily prepared when one once gets the "hang" of it and is willing to take pains. Directions should be carefully followed by those who are unfamiliar with its preparation.

The ingredients of the Bordeaux mixture are blue vitriol, lime, and water. The ingredient which kills the fungus is the

Digitized by Google

blue vitriol. The purpose of the lime is to prevent the injury to the foliage which a simple solution of blue vitriol would cause.

The proportion of the ingredients may be varied considerably. The formula which was recommended in Bulletin 27 of this Station still seems to us a satisfactory one, namely:

Blue vitriol	1 lb.
Lime, fresh	$\frac{2}{3}$ "
Water	10 gals.

As the quantity most frequently prepared would be a barrel the formula may be given as follows:

Blue vitriol	5 lbs.
Lime	$3\frac{1}{3}$ lbs.
Water	1 bbl. (45 to 50 gals.)

For the details of preparation see Bulletin No 45 of this Station.

Digitized by Google

Digitized by Google

Digitized by Google

Sci 1636.35

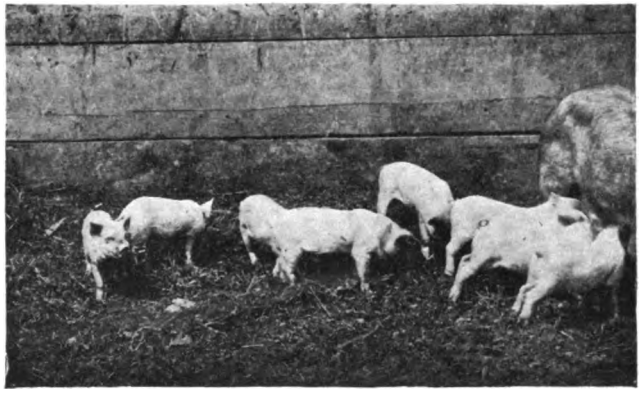
Bulletin 66 September, 1899

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

Experiments in Pig Feeding

BY CHARLES WM. BURKETT



I. Pumpkins, Raw and Cooked; Apples and Pumpkins; Cornmeal and Bran; and Cornmeal

II. Bran Fermented and Unfermented; Bran and Cornmeal; and Cornmeal

III. Corn and Cob Meal; and Corn on Ear

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL.

HON. FRANK JONES, *Chairman,* Portsmouth.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary,* Andover.
HON. JOHN G. TALLANT, Pembroke.
PRES. CHARLES S. MURKLAND, *ex officio,* Durham.

THE STATION COUNCIL.

PRES. CHARLES S. MURKLAND, A. M., PH. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director* and *Chemist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
FRANK WM. RANE, B. AGR., M. S., *Horticulturist.*
CHARLES WM. BURKETT, M. S., *Agriculturist.*
FREDERICK S. JOHNSTON, B. Sc., *Associate Agriculturist.*

ASSISTANTS.

WILLIAM F. FISKE, *Assistant Entomologist.*
CLARENCE W. WAID, B. S., *Assistant Horticulturist.*
HARRY A. CLARK, B. S., *Assistant Chemist.*
HARRY P. RICHARDSON, B. S., *Assistant in Agriculture.*
ROSCOE H. SHAW, B. S., *Assistant in Chemistry.*
FREDERICK C. KEITH, *Clerk.*

Digitized by Google

EXPERIMENTS IN PIG FEEDING

BY CHARLES WM. BURKETT

Dairying and the raising of pigs go hand in hand in New Hampshire. The latter is necessary for the profitable utilization of the skim-milk, while the former is one of the leading agricultural industries of the state.

Among the chief points of practical interest and importance in pig feeding are the kinds of feeding stuffs to use in connection with skim-milk, and the most economical way to use them.

Experiments with the following combinations of feeding stuffs have recently been conducted at this station and the results are given in this bulletin:

I. Pumpkins, cooked and uncooked; apples and pumpkins; cornmeal; cornmeal and bran.

II. Bran, fermented and unfermented; bran and cornmeal; cornmeal.

III. Corn and cob meal; corn on ear.

These experiments were conducted during the past year with pigs raised at this station. The pigs were a cross of Chester white sows and a Berkshire boar. Up to the time of the experiments they were fed a ration consisting of skim-milk, corn, and middlings.

EXPERIMENT NO. I.

PUMPKINS, COOKED AND UNCOOKED; APPLES AND PUMPKINS; CORNMEAL AND BRAN; CORNMEAL.

This experiment as planned and conducted was to determine the effect of cooking pumpkins and apples, comparing them cooked and uncooked with cornmeal and cornmeal and bran. Bran was used in this and the second experiment because many New Hampshire farmers purchase bran as a dairy food, and from this quantity the pig food is taken to feed in connection with the skim-milk.

Pumpkins were raised at this station at a cost of 40 cents per ton, and while it is often said that pumpkins are principally hollow space and water it should be noted that the cost of production is next to nothing. The apples used were the common cider apples, or windfalls, and valued at 10 cents per bushel, the price usually paid.

Digitized by Google

In this experiment eighteen pigs, weighing about 140 pounds each, were divided into six lots, three in a lot.

The following rations were fed:

Lot 1. Milk, cornmeal, and pumpkins, cooked.

Lot 2. Milk, cornmeal, and pumpkins, uncooked.

Lot 3. Milk and pumpkins, raw.

Lot 4. Milk and cornmeal.

Lot 5. Milk, and pumpkins and apples, half and half, cooked.

Lot 6. Milk, cornmeal and bran, half and half.

The gain in live weight and the average daily gain of each pig is shown in the following table:

TABLE I.

Gain in Live Weight by feeding Pumpkins, cooked and uncooked, Cornmeal, Cornmeal and Middlings, and Apples and Pumpkins.

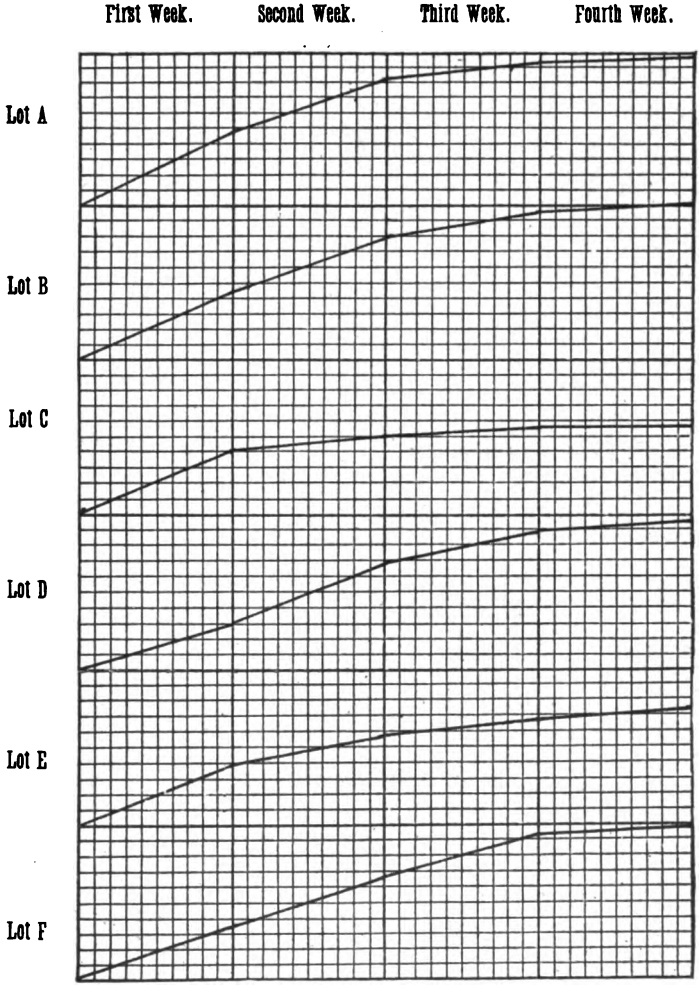
Lot and Kind of Feed.	Weight at beginning.	Weight at ending.	Gain.	No. days.	Average lbs. gained per day.
Lot A. Milk, Cornmeal, Pumpkins (cooked)	416	582	166	25	2.21
Lot B. Milk, Cornmeal, Pumpkins (uncooked)	426	596	170	25	2.26
Lot C. Milk, Pumpkins (uncooked)	423	507	84	25	1.12
Lot D. Milk, Cornmeal,	418	566	148	25	1.97
Lot E. Milk, Pumpkins, Apples,	420	536	116	25	1.54
Lot F. Milk, Corn, Bran,	428	590	162	25	2.16

It will be noted that the greatest gain was made by the lots having cornmeal as a part of the ration, the pumpkin-fed lot being in the lead. The least gain was made by the lot receiving only milk and raw pumpkins. The table shows there was a range in daily gain from 1.12 pounds in the lot fed raw pumpkins to 2.26 pounds in the lot receiving cornmeal in connection with raw pumpkins. We also see there was

Digitized by Google

but little difference in lot gain and average daily gain where pumpkins were fed cooked or raw.

The chart below shows the weekly gains and variations in gain for each lot for the whole period:



A clearer idea of the feeding values of these rations is given in the next table.

Digitized by Google

TABLE II.

Comparative value of Pumpkins, cooked and raw. Cornmeal, Pumpkins and Apples, Bran and Cornmeal, with equal amount of milk in pig feeding.

Lot and Kind of Feed.	Days fed.	Feed eaten.				Feed for 100 lbs. gain.				
		Milk.	Grain.	Pumpkins.	Apples and pumpkins.	Gain.	Milk.	Grain.	Pumpkins.	Pumpkins and apples.
Lot A. Milk, Cornmeal, Cooked pumpkins,	25	630	514	742	.....	166	379	309	447	.....
Lot B. Milk, Cornmeal, Raw pumpkins,	25	630	514	1,348	.....	170	370	302	793	.....
Lot C. Milk, Raw pumpkins,	25	630	.....	3,798	.....	84	750	.....	4,520	.....
Lot D. Milk, Cornmeal,	25	630	549	.....	.....	148	492	377	.....	.....
Lot E. Milk, Apples cooked, Pumpkins cooked,	25	630	.....	.....	3,762	116	545	.....	.....	3,246
Lot F. Milk, Bran, Cornmeal,	25	630	636	.....	.....	162	388	392	.....	.....

The same amount of milk was fed to all the lots. The pumpkin-cornmeal lots also were fed an equal amount of cornmeal. In the four pumpkin-fed lots, the pigs were allowed all the pumpkins they would eat. The reader will observe that much less of the cooked ration was eaten. However, where no cornmeal was fed there was a much larger amount eaten to furnish a sufficient amount of digestible nutrients. By further examining the table we see that for gain of each lot there was a considerable difference in necessary amount of food to produce 100 pounds gain.

COST OF FOOD.

The cornmeal was bought at $16 per ton and $17 per ton was paid for the bran. The skim-milk fed was from our own dairy and has been considered worth 20 cents per hundred pounds. The pumpkins were raised at this station at a cost of 40 cents per ton, and the apples were charged at the rate of 10 cents per bushel.

Going now to the next table we see the financial results from feeding the six lots.

Digitized by Google

TABLE III.

FINANCIAL SUMMARY IN FEEDING TO PIGS

Pumpkins, cooked and uncooked; apples and pumpkins; cornmeal; and cornmeal and bran.

Lot.	KIND OF FEED.	Amount of feed eaten.	Cost of food.	Market value of gain at 5½ cts. per pound.	Profit.	Cost per pound gain.
A.	Milk	630	5.52	9.13	3.61	$0.0332
	Cornmeal	514				
	Cooked pumpkins	742				
B.	Milk	630	5.64	9 35	3.71	.0331
	Cornmeal	514				
	Raw pumpkins	1,348				
C.	Milk	630	2.01	4.62	2.62	.0239
	Raw pumpkins	3,798				
D.	Milk	630	5.65	8.14	2.49	.0381
	Cornmeal	549				
E.	Milk	630	5.39	6.38	.99	.0464
	Pumpkins	1,881				
	Apples	1,881				
F.	Milk	630	6.51	8.91	2.40	.0401
	Cornmeal	318				
	Bran	318				

Value of feeds — Milk, 20 cents per 100 lbs.; pumpkins, 40 cents per ton; apples, 10 cents per bushel; cornmeal, $16 per ton; bran, $17 per ton.

It will be noticed from this table that the lots fed cornmeal wholly, or in part, had the highest market value, but it should be borne in mind that the cost of food was greater, hence highest profit does not necessarily follow.

Again, the highest market value was from the lot fed raw pumpkins and cornmeal. Close to this lot in value are the lots fed cooked pumpkins and cornmeal; cornmeal, and cornmeal and bran. There was but little difference in the cost of the food for these lots, the cornmeal-bran ration being the highest.

The lot fed raw pumpkins and milk brought in the least money, but the cost of the food was less by half than any of the other lots. Estimating the cost for each pound of gain we find the raw-pumpkin lot produced a pound of gain at a cost of only 2.39 cents, while all the other lots required over

Digitized by Google

3 cents' worth of food to produce one pound of gain, and the corn-bran ration cost over 4 cents per pound. The highest cost to produce a pound of gain was in the apple-pumpkin ration, where 4.64 cents of food was required to produce one pound of gain. This was due to the price of apples. The latter, even at the low price of 10 cents per bushel proved less economical as a food for feeding these pigs than any of the other rations, and where they were used in connection with pumpkins the average profit for the whole period was but 33 cents for each pig.

All things considered, the lots fed pumpkins, either raw or cooked, in connection with cornmeal, produced the greatest profit, and at least cost for each pound gain, live weight.

CONCLUSIONS FROM THIS EXPERIMENT.

1. The cooking of pumpkins does not increase their feeding value.
2. When pumpkins are available for pig feeding they can be fed most economically in connection with cornmeal.
3. While raw pumpkins fed in connection with milk produced a pound of gain at small cost, so few pounds were propuced it is advisable to feed cornmeal with them.
4. Apples, even at the low price of 10 cents per bushel, are not an economical food for pigs.
5. Bran is not desirable as a food for pigs, even if fed with cornmeal. This is further considered in the following experiment.

EXPERIMENT NO. II.

FEEDING VALUE OF BRAN, FERMENTED AND UNFERMENTED; BRAN AND CORNMEAL; CORNMEAL IN PIG FEEDING.

This experiment also was conducted with pigs raised at this station. The writer has been frequently told that some farmers in the state are in the habit of fermenting and souring bran before feeding it to their pigs, holding that the best gain is made by so doing.

With this in mind, the writer outlined the following experiment and fed four lots of pigs, three in a lot, for 120 days. The pigs used were from a cross between Chester white sows and Berkshire boar, and at the beginning of the experiment weighed from 45 to 50 pounds each.

The experiment was divided into two periods; the first for 99 days, and the second 21 days.

During the first period,—

Lot A was fed fermented bran and milk.

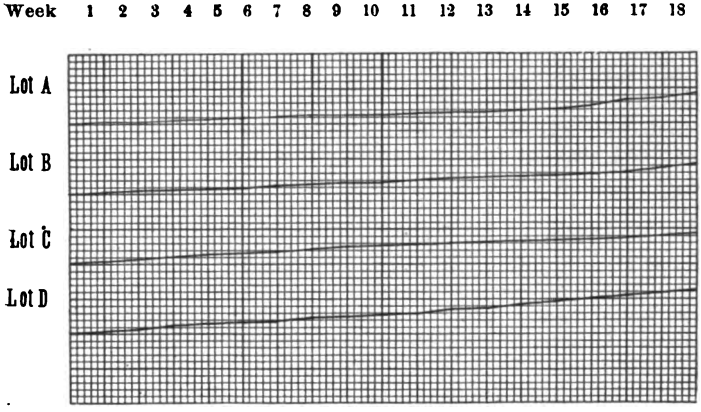
Lot B was fed unfermented bran and milk.

Lot C was fed bran, cornmeal, and milk.

Lot D was fed cornmeal and milk.

Digitized by Google

At the end of the period all four lots were fed for 21 days on a ration consisting of milk and cornmeal. Each lot was weighed weekly during the two periods. The chart below marks the fluctuations of gain:



In fermenting the bran it was steamed in a barrel and left for 10 days before it was used. By this time it was quite sour and had undergone fermentation to some extent.

The table below gives the gain in live weight and the average daily gain during both periods:

TABLE IV.

Gain in live weight and average daily gain by periods.

Lot.	Ration—First Period.	Weight at beginning.	Weight at end.	Gain.	Number of days.	Daily gain.	Average daily gain.
A.	Fermented bran	141	321	181	99	1.83	.61
B.	Unfermented bran	144	352	208	99	2.10	.70
C.	Bran and cornmeal	143	370	227	99	2 29	.76
D.	Cornmeal	141	464	323	99	3.24	1.08
	SECOND PERIOD.						
A.	Cornmeal	321	412	91	21	4.33	1.44
B.	Cornmeal	352	430	78	21	3.71	1.24
C.	Cornmeal	370	426	56	21	2 66	.88
D.	Cornmeal	464	551	87	21	4.14	1.38

Digitized by Google

The table is full of interest. There is a gradual increase in weight from the fermented ration fed to Lot A to the cornmeal ration fed to Lot D. The average daily gain is greatest in the cornmeal-fed lot, where it is 1.08 pounds, while the fermented-bran ration shows an average daily gain of but .61 pounds; unfermented bran, .70 pounds, and bran-cornmeal ration, .76 pounds. This is quite decidedly in favor of the cornmeal ration.

When the second period was begun, the bran part of the rations was left off, and cornmeal was fed to all the lots. The bran-fed hogs, or Lots A and B, made a decided increase, and at the end of 21 days the fermented-bran fed hogs not only had made the greatest total gain, but the average daily gain increased from .61 pounds of the first period to 1.44 pounds in the second period. The other two lots, fed respectively cornmeal, and bran and cornmeal, made but little increase in average daily gain. The next table gives us the comparative values of each ration for the first period.

TABLE V.

Comparative value of Fermented Bran, Unfermented Bran, Bran and Cornmeal, and Cornmeal for Pig Feeding.

Lot and Kind of Feed.	Days fed.	Feed Eaten.		Gain.	Feed for 100 lbs. Gain.	
		Grain.	Milk.		Grain.	Milk.
Lot A, fermented bran	99	527	1740	181	291	906
Lot B, unfermented bran	99	668	1921	206	322	923
Lot C, cornmeal and bran, equal parts	99	699	2004	227	308	882
Lot D, cornmeal	99	852	2144	323	263	663

At the end of the 99 days cornmeal alone was fed with the following results:

Digitized by Google

TABLE VI.

Results obtained by Feeding Cornmeal to above Lots to End of Experiment.

Lot.	Days fed.	FEED EATEN.		Gain.	FEED FOR 100 LBS. GAIN.	
		Grain.	Milk.		Grain.	Milk.
Lot A.	21	300	556	91	329	720
Lot B.	21	251	588	78	321	753
Lot C	21	229	616	56	409	1,100
Lot D.	21	314	783	87	372	900

In the next table the comparative values of the four rations for the two periods have been combined, giving us the results for the whole period.

TABLE VII.

Results obtained in feeding during whole period.

Lot.	No. of Days.	FEED EATEN.		Gain.	FEED FOR 100 LBS. GAIN.	
		Grain.	Milk.		Grain.	Milk.
Lot A	120	827	2396	272	304	881
Lot B	120	919	2309	286	321	872
Lot C	120	928	2620	283	327	926
Lot D	120	1166	2827	410	284	689

It is of interest to note that the cornmeal-bran lot consumed the greatest amount of food for each 100 pounds gain, followed in order by the unfermented-bran and fermented-bran lots. The cornmeal lot produced not only the greatest gain, but at the least consumption of food.

COST OF FEED.

The same prices were paid for the feed as in the previous experiment. The table following gives the financial summary for the two periods.

Digitized by Google

TABLE VIII.

Financial Summary for the Two Periods.

Lot and Kind of Feed.	Total gain.	Total cost of feed.	Cost per pound of gain for whole period.	Market value of gain at 5½c.	Profit.
Lot A, First 99 days, fermented bran, Following 21 days, cornmeal,	272	$10.35	$0.0380	$14 96	$4.61
Lot B, First 99 days, unfermented bran, Following 21 days, cornmeal,	286	11.52	.0392	15.73	4.21
Lot C, First 99 days, bran and corn meal, equal parts, Following 21 days, cornmeal,	283	9.70	.0343	15.57	5.87
Lot D, Whole period of 120 days, corn meal,	410	13.61	.0332	22.55	8.94

It will be seen at once in consulting the table that the greatest market value was from the cornmeal-fed lot, as was also the greatest profit produced at the least cost per pound.

The bran-cornmeal lot was materially below this, but slightly in excess of the bran-fed lots.

It should be noted that the greater part of the gain for food consumed in the bran-fed lots was made during the second period, when cornmeal was fed as the only grain feed.

CONCLUSIONS FROM THIS EXPERIMENT.

1. There is but little gained in fermenting bran for pig-feeding.
2. Bran is undesirable as a feeding stuff for pigs, fed either alone or in combination with cornmeal.

EXPERIMENT NO. III.

EAR CORN COMPARED WITH GROUND CORN AND COB FOR PIGS.

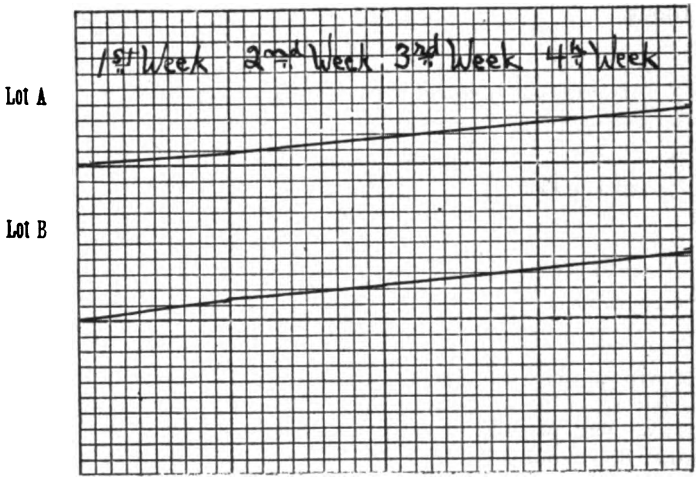
The practical question arises as to the economy of grinding corn for pig feeding. When we consider that millers charge eight cents per bushel for grinding and add to this the cost of hauling corn to and from the mill, the question becomes one of considerable importance.

This led us to divide the available corn we had into two equal quantities; one half was taken to the mill and ground, grain and cobs, the other half was reserved whole for feeding in comparison with that which was ground.

Digitized by Google

Six hogs, weighing about 50 pounds each, were divided in two as equal lots as could be made. They were the same kind as previously described. Lot A was fed corn in the ear; Lot B was fed ground corn and cob. Both lots were fed the same quantities of both milk and corn daily.

The chart below shows the weekly variations of gain during the four weeks that the experiment lasted. On account



of the limited amount of grain on hand, the experiment could be conducted for only four weeks. The table below gives the gain for the period and the average daily gain for each pig.

TABLE IX.

Feeding value of Corn on Cob and Corn and Cob Ground in Pig Feeding.

Lot and Feed.	Weight at beginning.	Weight at end.	Gain.	No. of days.	Average daily gain.
Lot A, corn in ear	152	220	68	28	.81
Lot B, ground corn	148	219	71	28	.87

Digitized by Google

In looking over the results we see there is but a slight margin in favor of the lot fed ground corn and cob. During the entire four weeks, with same food, differing only in the conditions fed, there was a difference of but 3 pounds for the whole period, and the difference in the average daily gain was but .06 pounds in favor of Lot B.

The next table shows the comparative value of the two methods.

TABLE X.

Ear Corn or Ground Corn and Cob in Pig Feeding.

Lot and Feed.	No. of days.	Feed Eaten.		Gain.	Feed for 100 lbs. Gain.	
		Milk.	Grain.		Milk.	Grain.
Lot A, corn on ear	28	607	227	68	892	333
Lot B, corn ground	28	607	227	71	855	319

It will be observed that the same amount of milk and corn was fed in both cases, with the result that the ear corn lot required 892 pounds of milk and 333 pounds of grain, as against 855 pounds of milk and 319 pounds of grain of the ground corn and cob to produce 100 pounds of gain—live weight. This is a difference of 14 pounds of corn, including the cob. At the rate of $16 per ton, the 14 pounds has a value of 11.2 cents.

Counting the cost of grinding a bushel of corn at eight cents, 100 pounds would cost 12 cents for grinding. The 14 pounds gained by grinding has therefore a less feeding value than the amount paid for grinding, and we have saved, at the same time, the expense and labor of hauling to and from the mill.

CONCLUSIONS FROM THIS EXPERIMENT.

1. Ground corn and cob has a slightly better feeding value than corn on the ear.

2. For practical purposes it is more economical to feed corn on the ear rather than hauling to the mill and grinding for feed.

Digitized by Google

Digitized by Google

Digitized by Google

H. A. MORGAN.
Baton Rouge, La.
No. _____
Rec'd _____

Sci 1636.38

Larva

THE SPINY ELM CATERPILLAR

Bulletin 67

October, 1899

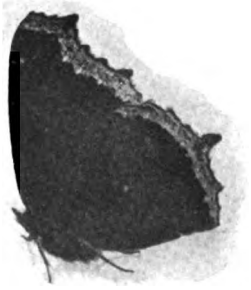
Chrysalis

BY

Clarence M. Weed

NEW HAMPSHIRE
COLLEGE
AGRICULTURAL EXPERIMENT
STATION

DURHAM



Butterfly

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

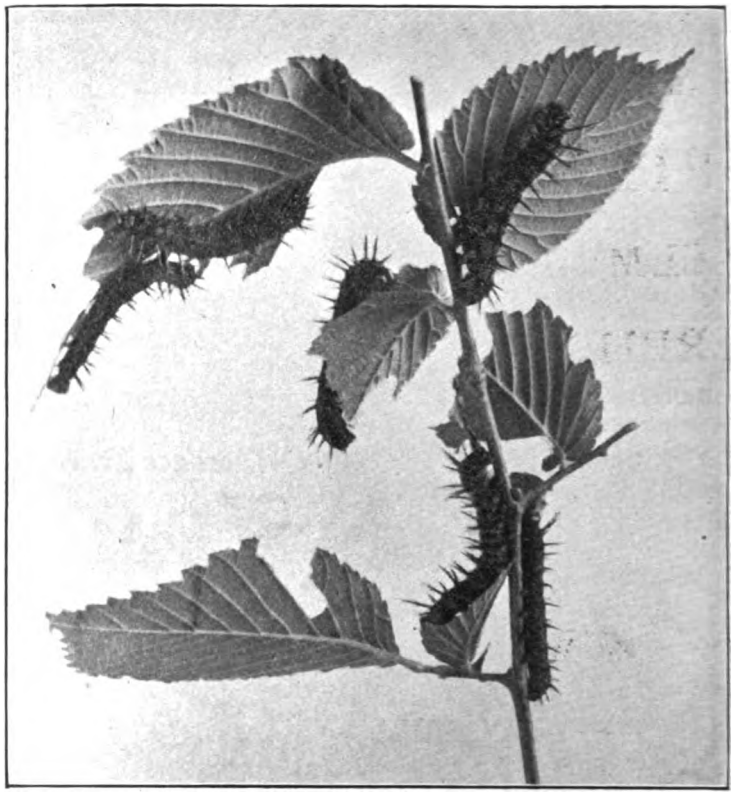


Fig. 40. Spiny Elm Caterpillars at work.

Digitized by Google

THE SPINY ELM CATERPILLAR

BY CLARENCE M. WEED

In New Hampshire during the last three years there have been frequent complaints of injury to the foliage of elm trees by a black, spiny caterpillar. The extent of the injury appears to have been increasing from year to year until, in 1899, it attracted very general attention. In some localities the damage done was compared to that done by the hosts of the Forest Tent Caterpillar or Maple Worm. The correspondence of this station, as well as trips in the field, has shown the desirability of a full statement of the life history of the insect, and of the remedial measures to be taken against it.

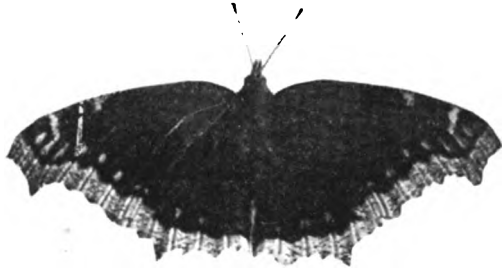


Fig. 41. Mourning Cloak or Antiopa Butterfly.

This bulletin, therefore, is issued: it embodies a statement of the results of the studies of the insect carried on at this station by the entomologist and his assistant, Mr. W. F. Fiske, as well as a summary of the previous knowledge of the species. It aims, in short, to place before the people of the state a brief account of all that is known of the pest in so far as it may be of practical value.

Digitized by Google

THE LIFE HISTORY OF THE CATERPILLAR

During sunny days in spring one may often see a beautiful purple-black butterfly, having a cream-colored border along the outer margin of its wings, flying leisurely about. This butterfly is called the Mourning Cloak or Antiopa Butterfly; it is represented nearly natural size in Fig. 41. It has passed the winter in this adult condition, having found shelter in some retreat where it was not directly exposed to the storm and stress of the weather.

Fig. 42. Butterfly just after depositing eggs (*a*).

When the leaves of elm, willow, and poplar trees are nearly expanded these butterflies deposit their eggs upon the twigs. These eggs are laid in clusters encircling the twig, there being twenty or more in each cluster; their general appearance is shown in Fig. 42. In the act of oviposition the butterfly keeps her wings spread out, moving the body and abdomen about as the placing of the eggs necessitates. About two weeks after the clusters of eggs are thus laid upon the twigs of the food-plant they hatch into small blackish caterpillars, each emerging from the egg-shell through a small hole that it eats out of the upper surface. They thus enter upon the second stage of

Digitized by Google

their life-history—the larva or caterpillar stage. As soon as hatched they crawl to the nearest leaf, upon which they range themselves side by side, with their heads toward the margin of the leaf. They feed in this position, nibbling at the green surface of the leaf-blade, and leaving the network of veins untouched.

Fig. 43. Denuded twigs showing cast skins of the caterpillars.

These caterpillars continue to feed in this manner for about a week, remaining side by side when feeding, and marching in processions from one leaf to another, as the food supply is exhausted. Wherever they go each spins a silken thread on the surface traversed, so that the combination of all the threads makes a sort of carpet that serves as a foothold for

Digitized by Google

the caterpillars. At the end of the week they moult or cast their skins, a process in which the skin of each insect splits open along the back, and the caterpillar crawls out of it, being covered with a new skin that had been formed beneath the old one. This new skin stretches somewhat after the caterpillar emerges, so that the insect is able to increase con-

Fig. 44. Colony of Caterpillars feeding upon willow.

siderably in size. At the period of moulting the caterpillars remain quiet for a short time, but they soon become active again and begin feeding with increased voracity.

During the next three weeks this moulting process is repeated three times, the caterpillars becoming larger each time, and leaving their cast skins upon the denuded twigs, as shown in Fig. 43. They soon scatter more or less over neighboring

Digitized by Google

leaves, but remain in closely associated colonies, as represented in Fig. 44. As they increase in size they eat more and more of the leaf substance; when half grown they devour all but the midrib and the side veins, but when they get larger only the midribs are left, as may be seen in Fig. 43.

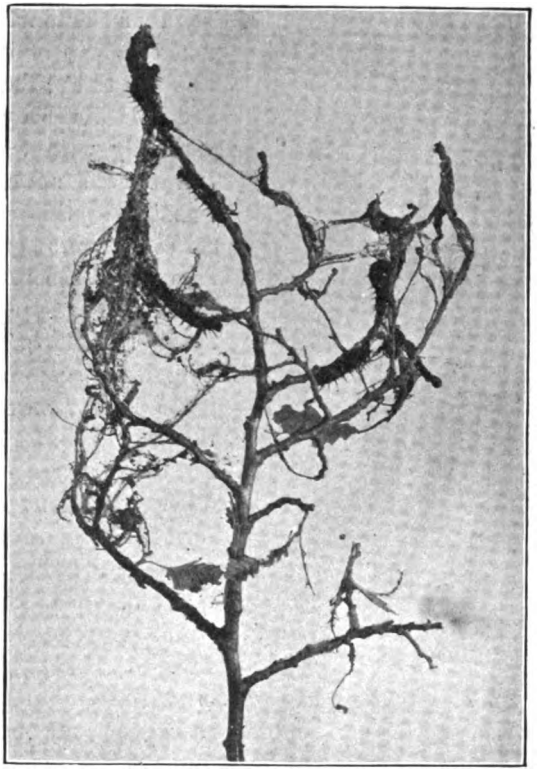


Fig. 45. Denuded Elm twig showing carpet web.

The carpet-web that they form becomes more conspicuous as the caterpillars develop, and often binds the ends of neighboring twigs together, especially in those places to which the caterpillars retire for rest after feeding. Examples of such webbing of the denuded surface are shown in Figs. 45 and 50.

Digitized by Google

About four weeks from the time of hatching these Spiny Elm Caterpillars become full grown. They then leave the tree or shrub on which they have been feeding and scatter about, seeking some sheltered situation. Having found this,—perhaps beneath a stump or along the underside of a fence,—each caterpillar spins a web of silk along the surface. It then entangles the hooked claws of its hind legs in this silken web and lets its body hang vertically with the head end curved upward. It remains in this position for some hours before the skin along the back just behind the head splits apart and is gradually wriggled upward until it is finally all removed, and there hangs in place of the caterpillar a peculiar object having no definite form. But it rapidly assumes a definite form—that of the chrysalis which is represented in Fig. 46. These pictures will show sufficiently the shape and size of the chrysalis, which is of a grayish brown color, different specimens varying somewhat in shade.

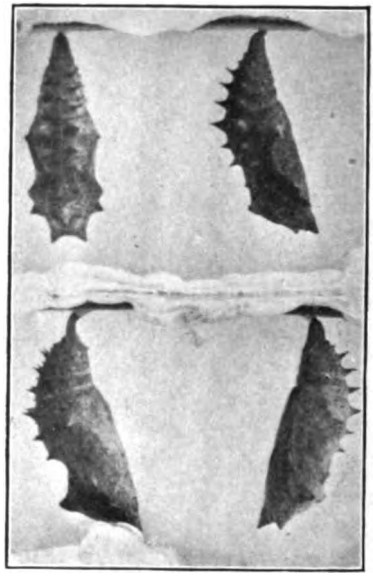


Fig. 46. Four views of the chrysalis. Natural size.

In this quiet chrysalis the insect is apparently almost as inert as a mummy. If you touch it, it will wriggle a little but otherwise it hangs there mute and helpless. On the inside, however, the tissues are being made over in such a wonderful way that in about two weeks, from the mummy-case into which the caterpillar entered, there comes a beautiful butterfly. When it first breaks the mummy-shell its wings

Digitized by Google

are very small, although its body, "feelers," and legs are well developed. By means of the latter it clings to the empty chrysalis while its wings expand. A butterfly in this position with its wings nearly expanded, is shown in Fig. 47, which like all but one of the photographs of the insects illustrated in this bulletin was taken from the living specimen. In the course of half an hour the wings become fully developed, and the butterfly is likely to crawl to some firmer support where it will rest an hour or so before venturing upon its first flight.

FOOD-PLANTS OF THE CATERPILLARS

The caterpillars of the Mourning Cloak Butterfly are restricted to comparatively few food-plants. In regions where they are not especially abundant they are likely to be found upon willow, poplar, or elm. In general our observations indicate that they are as likely to be found on any one of these food-plants as upon either of the other two; but in certain localities where they become especially abundant it seems that they are more likely to occur upon the elm. There is considerable evidence to show that they prefer the American elm to other species of the genus, although in the case of willow and poplar there seems to be little if any preference as to species. Miss C. G. Soule has seen the butterflies depositing their eggs upon the white and canoe birch, and in Labrador and Europe it has been recorded as feeding upon a species of birch. There is one record of the caterpillars having been found feeding upon the hackberry (*Celtis occidentalis*), and

Fig. 47. Butterfly hanging to empty chrysalis as its wings expand.

Digitized by Google

also one of their having fed greedily upon the leaves of rose, and another of their having almost defoliated a pear tree. Linden and nettle are also included in the European lists of the food-plants of this species. It is evident, however, that all of these except the three first named—willow, poplar, and elm—are to be regarded as exceptional cases, and that the normal food of the species is the foliage of a plant belonging to one of these three genera.

BROODS AND HIBERNATION

It has generally been supposed that this species is double-brooded in central and southern New England, the butterflies of the first brood appearing early in July. These are said to deposit eggs which hatch into caterpillars that mature into butterflies early in September. These butterflies live through the winter, laying eggs the following spring.

Unless the summer of 1899 was exceptional, however, this idea of the yearly history of the species will have to be modified, for during this season, in New Hampshire and Vermont at least, there was practically but one brood. Continual observations by Miss Caroline G. Soule at Brandon, Vt., and by Mr. Fiske and myself in this state show that there was scarcely a trace of a second brood of caterpillars, for with all our searching in July and August we found but a single colony of larvæ. These were discovered on a willow at Durham August 3. During the period when the second brood of caterpillars are supposed to be at work, I traveled by carriage and on foot over hundreds of miles of roadway in southern New Hampshire and southern Maine, and though there was everywhere evidence of the presence of the first brood, none of the second were seen. During the same period Miss Soule was watching in the region of Brandon, Vt., and Mr. Fiske took an extended trip through central New Hampshire. But save for the single colony mentioned, all our looking did not reveal a trace of the second brood. Nor was there a single complaint from correspondents of injury at the supposed time of the second brood, although many accounts of the depredations of the first brood were received.

Digitized by Google

In view of all this evidence it seems safe to conclude that in the region under consideration a single brood is the rule rather than the exception. This involves the conclusion that the butterflies seen upon the wing early in autumn are the same ones that developed in July, and that these same butterflies remain alive through the winter and until, in the following May, they lay their eggs. Thus there is a period of ten months of existence in the butterfly state, an extraordinary length of time for a butterfly to live.

To a large extent the butterflies disappear in August, and the question arises as to what becomes of them. Our observations lead to the conclusion that they go into summer quarters similar to those which they seek out for winter shelter. Apparently they fly about for a few days after coming from the chrysalis and then retire to cool woods, where under the side of a log or beneath the loose bark of a dead tree they settle down and to all appearances go to sleep. The instinct to remain quiet is very strong in these butterflies. In making the photographs that illustrate this bulletin I found that even shortly after coming from the chrysalis the butterflies when disturbed would fold their wings with the antennæ between them, and drawing the legs against the body, would lie quietly on their sides for a long time; the position thus assumed by the living butterfly is shown in Fig. 48. These same butterflies would also hang downward from a limb by the hour in the hibernating position as shown in Fig. 49.

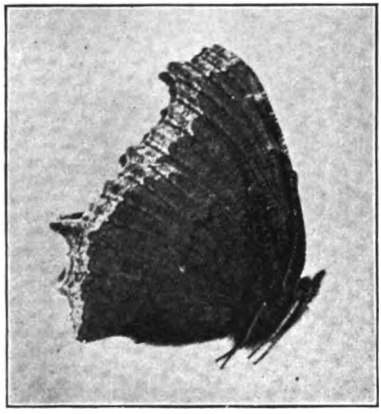


Fig. 48. Butterfly "playing 'possum".

In the cooler weather of early autumn the butterflies come from their summer retreats and fly about in the sunshine.

Digitized by Google

They are especially likely to be seen along the borders of woods or in open glades. At this time they love the sunshine, and will settle in a sunny place to bask in it.

On a spring-like day early in November (the eighth) I came across one of these butterflies basking in the sunshine upon the ties of a railway track. It rested with its wings wide open. On being disturbed it would fly a short distance and then alight, and I was interested to notice that after alighting it would always turn about until the hind end of its

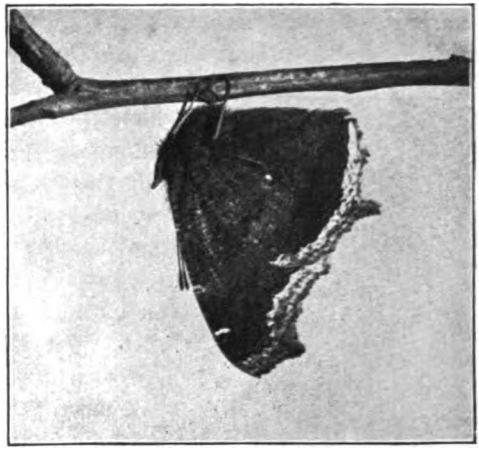


Fig. 49. Butterfly hanging from branch in hibernating position.

body pointed in the direction of the sun, so that the sun's rays struck its wings and body nearly at right angles. I repeatedly observed this habit of getting into the position in which the most benefit from the sunshine was received, and it is of interest as showing the extreme delicacy of perception toward the warmth of sunshine which these creatures possess.

During the colder part of the year in bright weather when these butterflies are most often abroad, they commonly hold their wings open when they alight, but during the warmer summer days they are more likely to rest with the wings closed.

Digitized by Google

When the warm days no longer tempt them abroad the Mourning Cloak Butterflies seek shelter in many sorts of situations,—under loose bark, in hollow trees, under culverts and bridges, in woodpiles, in crevices of rocks, alongside logs lying on the ground. In such retreats they remain until the sunshine of spring again calls them forth.

FEEDING HABITS OF THE BUTTERFLY

The Mourning Cloak Butterflies subsist upon a considerable variety of liquid food which they suck through their long tongues. In spring, when they first come from their winter quarters, they visit the stumps of recently cut trees and suck the exuding sap, a habit which they continue whenever opportunity offers. Mr. Fiske has noticed that they commonly sip the sap of maple twigs where the squirrels have gnawed the bark. A little later they visit the willow catkins to suck the nectar secreted by these blossoms, and still later they hover about the delicate blossoms of the mayflower or trailing arbutus for a similar purpose. Probably many other flowers are thus rifled of their sweets, although this butterfly seems to be a less regular visitor to flowers than are many of its allies. A little later, when the aphides or plant-lice have become sufficiently abundant so that the so-called "honey-dew" is to be found upon the infested shrubs, these Mourning Cloaks sometimes sip the liquid sweet from the surface of the leaves. In April and May they occasionally visit the flowers of moosewood, and later in the season have been observed upon the blossoms of the common milkweed. From the time the early apples ripen these butterflies may often be seen beneath the orchard trees sipping the liquids of the fallen and decaying fruit.

POPULAR NAMES OF THE BUTTERFLY

In Germany this butterfly is called *Trauermantel*, from the translation of which is derived the common American name, Mourning Cloak. Its other common name with us, Antiopa Butterfly, is derived from its Latin name,—*Vanessa antiopa*.

Digitized by Google

In England it is called the Camberwell Beauty, from its having been found at an early date at or near Camberwell. A still earlier title adopted for it in England was "The Grand Surprise," given by butterfly collectors because at the beginning of the century after a long absence it appeared in considerable numbers.

In most books upon insects the technical name of this butterfly is given as *Vanessa antiopa*. In his recent writings Mr. S. H. Scudder has called it *Euvanessa antiopa*, although in one of his earlier books he called it *Papilio antiopa*. Questions of nomenclature, however, need no consideration in this connection, and I mention these names only for the guidance of any reader that may wish to study what has been printed about the species.

THE CATERPILLARS NOT POISONOUS

During the earlier years of our country's history many people regarded these caterpillars as "venomous and capable of inflicting dangerous wounds." Dr. T. W. Harris states that he had known people to cut down poplar trees around dwellings to prevent the presence of such dangerous caterpillars. But these insects are not poisonous, and may be handled with little fear of injury, although the sharp spines might perhaps penetrate the delicate skin of a child's hand.

GEOGRAPHICAL DISTRIBUTION

The Mourning Cloak Butterfly is one of the most widely distributed insects in existence. Not only is it found in North America as far south as Bermuda, Florida, and Mexico, but it is also found throughout northern Europe, and in Asia and Japan. Consequently, as Mr. Scudder has said, it appears to be distributed "over the entire breadth of the northern hemisphere, below the Arctic circle as far south as the thirtieth parallel of latitude." This is an extraordinary distribution for an insect, and shows a remarkable power of adaptation to the varying surroundings in which the species occurs. In the northern United States this is one of the commonest and most familiar butterflies.

Digitized by Google

ABUNDANCE AND INJURIES

As a rule the caterpillars of the Mourning Cloak Butterflies are to be found only in occasional colonies, so that the damage they do attracts little if any attention. But sometimes the weather or other conditions are so favorable to their

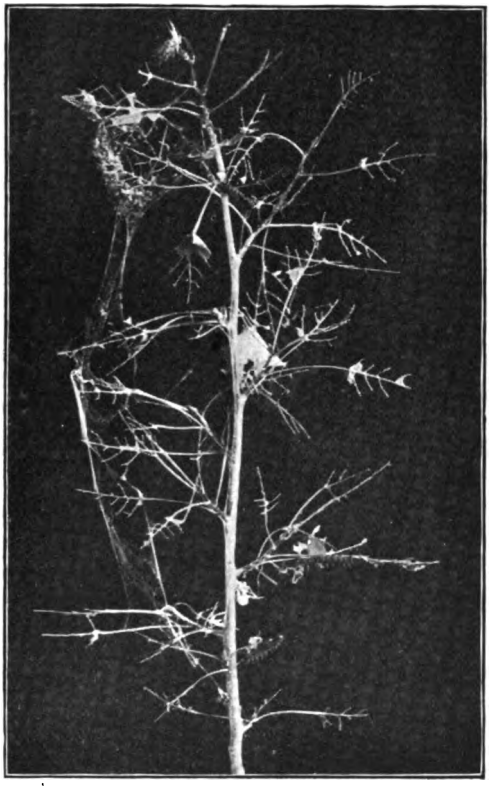


Fig. 50. Poplar twig denuded by caterpillars, showing carpet web.

development that they multiply beyond this normal limit and are to be found in great numbers. At such times serious damage is often done. In this country such local outbreaks of the species have frequently occurred, generally, however, over very limited areas. So far as I can learn the insect has

Digitized by Google

never caused such widespread destruction as the Forest Tent Caterpillar has recently caused in New England. In the tree plantations of the prairie regions of the West, these caterpillars are, according to Prof. Otto Lugger, "very injurious and sometimes denude whole rows of willows and poplars." The same observer adds: "They are still more fond of the leaves of elms, and I have seen them so numerous upon those trees in Michigan that branches were broken by their weight." In other regions of the West similar records have been made.

NATURAL ENEMIES

Like most other insects the Mourning Cloak Butterflies have many natural enemies to contend against. From the moment the egg is laid until the butterfly dies it is in constant danger.

Some of the eggs never hatch into caterpillars because a tiny fly, scarcely one twentieth of an inch in length, finds the egg mass, and deposits in each egg another egg,—the latter being microscopic in size. This tiny egg soon hatches into a maggot almost equally tiny, and the maggot grows by absorbing the contents of the butterfly egg. In due time it changes to a minute pupa, later to change to a minute fly like the one that laid the microscopic egg. This minute fly now gnaws a hole through the egg-shell of the butterfly and comes out into the world. The little creature that has thus developed at the expense of the egg of the butterfly is called an egg parasite. There are many species of these egg parasites and they attack the eggs of many kinds of insects. The particular species that develops in the eggs of the Mourning Cloak Butterfly is called by scientists *Telenomus grapiæ*.

After hatching from the egg the caterpillars are subject to the attacks of various parasites. One of these is quite minute,—not a great deal larger than the egg parasites. It is a tiny four-winged fly which deposits many eggs in a single caterpillar. The eggs hatch into tiny maggots that grow at the expense of the caterpillar, finally killing it and changing to four-winged flies again. As many as 145 of these para-

Digitized by Google

sites have been known to emerge from a single dead caterpillar. These little flies are called *Chalcids* by entomologists.

There is still another group of four-winged flies, some of which attack the Antiopa Caterpillars. These are much larger than the Chalcid flies and are called *Ichneumon Flies.* In the case of these only one or two parasites develop in each caterpillar or chrysalis.

In addition to these various four-winged flies there are certain two-winged flies, called *Tachinid Flies,* that develop at the expense of the caterpillars. In New Hampshire, during recent years, these appear to have been the most abundant parasites of these insects. An egg is laid on the skin of the caterpillar by a two-winged fly, similar in general appearance to Fig. 51. The contents of this egg shortly develop into a tiny grub that burrows through the egg-shell and the skin of the caterpillar into the inside of the body. Here it remains absorbing the body substance of its host and gradually increasing in size. In a few weeks it becomes fully developed in this grub state. By this time the caterpillar has become sluggish from the effects of the parasite. If the branch upon which it feeds is disturbed the other caterpillars are likely to crawl away, but it remains in its place. The caterpillars illustrated on the web in Fig. 45 were parasited specimens that thus remained after the others had crawled away.

Fig. 51. Tachinid fly. (Redrawn from Scudder.)

Shortly after becoming full grown the Tachinid grub breaks through the skin of the dying caterpillar and falling to the ground changes to a peculiar pupa; the outer skin of the grub turns brown and becomes hard, forming a protective covering for the body inside. A week or two later the insect undergoes another change and emerges as a two-winged Tachinid fly like the one that laid the egg some weeks before.

Our observations indicate that during the last season a comparatively small proportion of the caterpillars were affected by parasites of any kind.

Digitized by Google

PREDACEOUS INSECTS

Besides those insects which develop on the inside of the bodies of these caterpillars, called parasites, there are other insect enemies that attack them from the outside and devour them bodily. Such enemies are called predaceous insects. The most notable of these, perhaps, is a large beetle called the caterpillar hunter; it is known to entomologists as *Calosoma scrutator*. Some cases are on record in which this insect has been observed to destroy many of the Antiopa Caterpillars. In New Hampshire, however, this beetle is comparatively rare, and it can be relied upon for but little help.

In the Southern states a large reddish wasp has been observed to attack and destroy the Antiopa Caterpillars. There are probably also various other insect enemies at work, although definite observations upon them have not been recorded.

These Elm Caterpillars are such spiny creatures that comparatively few birds attack them. They are devoured, however, by the cuckoos, of which we have two species in New England,—the yellow-billed and the black-billed cuckoos. It is probable also that these insects are eaten by Baltimore orioles and various other birds.

These caterpillars are also greedily devoured by toads, but of course as a rule they do not come within reach of these useful animals.

REMEDIES

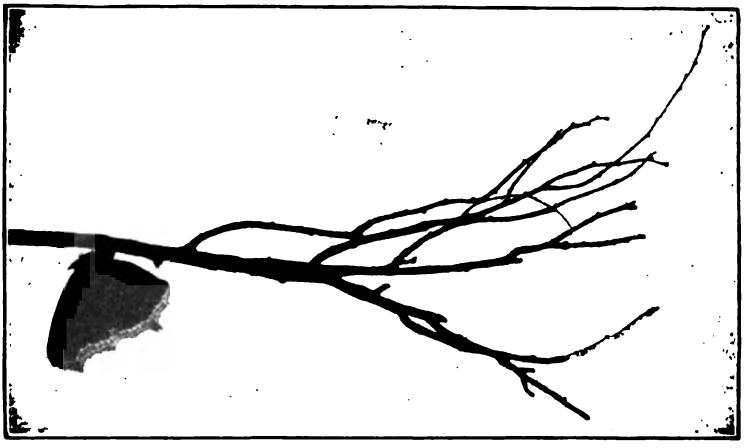
In general the most satisfactory remedy for these caterpillars is to cut off while they are still young the branch on which they are feeding, and crush or burn the insects. After they become larger they may be shaken off and crushed. Or the colonies may be brought down with a torch, care being taken to kill the caterpillars that fall to the ground, as probably many of them will not be seriously injured by the flame. Jarring the limbs with a padded mallet will also be a useful way of bringing down those out of reach; or they may be brought down by use of a strong stream of water from a force pump or hydrant.

Digitized by Google

These caterpillars are also open to destruction through spraying with arsenate of lead or other forms of arsenical poisons.

BANDING THE TREES IS USELESS FOR THESE CATERPILLARS

In one city in this state where the Spiny Elm Caterpillars were rather abundant last season, many owners of shade trees applied bands of various sorts to the trunks of the trees to prevent the injury. Presumably this was done on the theory that as bands are successfully employed against canker worms, they are equally good against other caterpillars. In the case of canker worms, however, the female moth which lays the eggs is wingless, so that the bands prevent her from ascending the trees. But with the Spiny Elm Caterpillar the parent insect that lays the eggs is a butterfly which can easily fly to the tops of the tallest trees. The eggs are deposited on the twigs by these butterflies, and the caterpillars remain in the close neighborhood of the place where they hatch until they are full grown. Consequently, any banding of the tree is a waste of energy so far as this insect is concerned.



Digitized by Google

Digitized by Google

Sci 1636.35

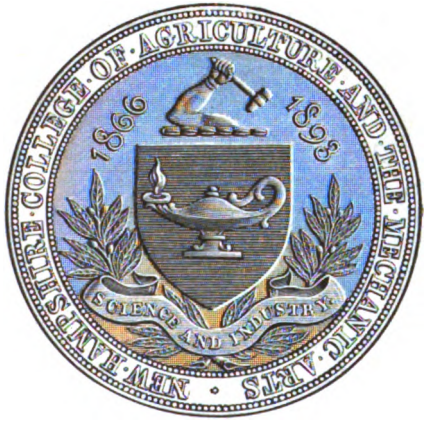
Bulletin 68. **November, 1899.**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

ELEVENTH ANNUAL REPORT

BY CHARLES S. MURKLAND



NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

Digitized by Google

Sci 1636.35

Bulletin 68. November, 1899.

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

ELEVENTH ANNUAL REPORT

BY CHARLES S. MURKLAND

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL.

HON. JOHN G. TALLANT, *Chairman*, Pembroke.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HENRY W. KEYES, A. M., Haverhill.
PRES. CHARLES S. MURKLAND, *ex officio*, Durham.

THE STATION COUNCIL.

PRES. CHARLES S. MURKLAND, A. M., PH. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director* and *Chemist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
FRANK WM. RANE, B. AGR., M. S., *Horticulturist.*
CHARLES WM. BURKETT, M. S., *Agriculturist.*
FREDERICK S. JOHNSTON, B. S., *Associate Agriculturist.*

ASSISTANTS.

WILLIAM F. FISKE, *Assistant Entomologist.*
CLARENCE W. WAID, B. S., *Assistant Horticulturist.*
ROSCOE H. SHAW, B. S., *Assistant Chemist.*
HARRY A. CLARK, B. S., *Assistant Chemist.*
HARRY P. RICHARDSON, B. S., *Assistant in Agriculture.*
FREDERICK C. KEITH, *Clerk.*

Digitized by Google

ELEVENTH ANNUAL REPORT

The eleventh annual report of the New Hampshire College Agricultural Experiment Station, for the year ending October 31, 1899, is herewith respectfully submitted. The reports of the department will be found upon the pages indicated in the following list:

Financial statement	145
Report of the Vice-Director	147
Department of Horticulture	151
Department of Agriculture	154
Department of Entomology	157
Department of Bacteriology	158
Department of Meteorology	164

CHARLES S. MURKLAND,
Acting Director.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ending June 30, 1899.

RECEIPTS

Cash received from United States treasurer	$15,000.00

EXPENDITURES

Cash paid for salaries	$7,920.91
labor	1,605,51
publications	2,368.74
postage and stationery	85.02
freight and express	109.00
heat, light, and water	979.81
chemical supplies	126.35

Digitized by Google

Cash paid for seeds, plants, and sundry supplies	$132.36	
fertilizers	150.00	
feeding stuffs	101.00	
library	299.71	
tools, implements, and machinery	8.63	
furniture and fixtures	131.63	
scientific apparatus	707.46	
traveling expenses	60.11	
contingent expenses	5.80	
building and repairs	207.96	
		$15,000.00

SUPPLEMENTARY STATEMENT

Receipts

Balance on hand	$340.55
Cash received from the State Board of Agriculture for analysis of fertilizers	656.25
	$996.80

Expenditures

Cash paid for salaries	$551.57	
Cash paid for feeding stuffs	21.85	
Balance	423.38	
		$996.80

We, the undersigned, duly authorized auditors of the corporation, do hereby certify that we have examined the books and accounts of the New Hampshire College Experiment Station for the fiscal year ending June 30, 1899; that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by us examined and found correct.

Digitized by Google

Also, that the recepits from fertilizer analyses have been duly expended and vouched for, as per supplementary statement.

And we further certify that the expenditures have been solely for the purposes set forth in the act of congress approved March 2, 1887.

(Signed)
JOHN G. TALLANT,
CHARLES S. MURKLAND,
Auditors.

Durham, N. H.

REPORT OF THE VICE-DIRECTOR

To Charles S. Murkland, Acting Director:

The different lines of work of the Agricultural Experiment Station and the progress made in them for the year ending October 31, 1899, are described in the reports from the different departments.

Nine bulletins have been issued during the year, including this annual report, namely,—

No. 60. Green Corn under Glass. By F. Wm. Rane.

No. 61. Inspection of Fertilizers in 1898. By Fred W. Morse.

No. 62. Forcing Pole Beans under Glass. By F. Wm. Rane.

No. 63. Third Potato Report. By F. Wm. Rane.

No. 64. The Forest Tent Caterpillar. By Clarence M. Weed.

No. 65. Notes on Apple and Potato Diseases. By Herbert H. Lamson.

No. 66. Experiments in Pig Feeding. By Charles Wm. Burkett.

No. 67. The Spiny Elm Caterpillar. By Clarence M. Weed.

No. 68. Eleventh Annual Report.

Digitized by Google

With the co-operation of the postmasters the list of persons in the state to whom bulletins are sent has been revised and enlarged, and it now includes nearly 7,000 names distributed among nearly all the postoffices in the state.

Changes and additions to the staff have been as follows:

APPOINTMENTS

Frederick S. Johnston, Associate Agriculturist. July.
Clarence W. Waid, Assistant Horticulturist. April.
Harry A. Clark, Assistant Chemist. August.
Roscoe H. Shaw, Assistant Chemist. October.
Harry P. Richardson, Assistant Agriculturist. October.
Frederick C. Keith, Clerk. August.

RESIGNATIONS

Clement S. Morris, Clerk. August.
Arthur Given, Assistant Chemist. September.
Harry E. Barnard, Assistant Chemist. September.
Elwin H. Forristall, Assistant Agriculturist. September.

Mr. Given has entered the employ of the American Steel and Wire Company at Worcester, Mass.; Mr. Barnard is assistant in the research laboratory of Dr. Wolcott Gibbs, Newport, R. I.; and Mr. Forristall is superintendent of the farm and dairy of the Walker-Gordon Company of Boston.

The following permanent improvements in buildings and fields have been made:

Storeroom in the basement of Nesmith Hall; birch floors in the bacteriological laboratories; division, by a plaster partition, of the large office in Nesmith Hall, into offices for the departments of horticulture and agriculture respectively; division of the large forcing house into three equal apartments; installation of Johnson's automatic system for regulating the temperature of the greenhouses; straightening and sloping the banks of the brook running through the experiment field.

Valuable additions have been made to the scientific apparatus, which include a Robert's dynamometer with lever and planimeter; a Bausch and Lomb microscope with continental

Digitized by Google

stand, triple nose-piece, three objectives, complete sub-stage attachment, and attachable mechanical stage; an Abbe's oleo-refractometer with heating attachment; and fifty sets of electrodes for soil-moisture measurements.

Additional insect cases and bookshelves have been built, and the files of bulletins and periodicals have been bound as far as practicable, up to the current year.

Department of Chemistry

The experimental investigations of the department of chemistry have been confined to studies of silage, apples, and potatoes. An unusually large amount of work has been done for the state board of agriculture, and the usual number of miscellaneous samples have been analyzed for the public.

Ninety-seven brands of fertilizers were analyzed for the board of agriculture as a part of the annual inspection of commercial fertilizers, and the results will be published in a bulletin in January next. The department also assisted the board in enforcing the oleomargarine laws, and examined, in the course of the work, 282 samples of butter and oleomargarine.

Of the miscellaneous analyses made for individuals, the following have been selected for publication in this report:

City Stable Manure

A sample of city stable manure was sent to the station, April 25, from Concord, by Hon. J. B. Walker, president of the board of agriculture. The sample measured one cubic foot in volume, weighed 38½ pounds at the laboratory, and was considered to represent an average lot of manure of its class.

The analysis of the sample gave the following results in percentage composition, and in pounds of fertilizing constituents per ton, and per cord weighing approximately 2½ tons.

	Per ct.	Lbs. per ton.	Lbs. per cord
Water	70.00	1,400.0	3,500.0
Organic matter	20.70	414.0	1,035.0
Nitrogen, total	0.69	13.8	34.5

Digitized by Google

Phosphoric acid, total . .	0.53	10.6	26.5
Potash, total	1.03	20.6	51.5
Potash, soluble in water . .	0.43	8.6	21.5

Spring Water

Since the publication of Bulletin No. 53, "The Farm Water Supply," some noteworthy results have been obtained from several unpolluted springs in different sections of the state, still further showing that our natural ground-waters are exceptionally pure and soft, and that water containing much chlorine and soluble salts must be regarded with suspicion and used with care.

Locality.	Composition. Parts in 100,000 of water. Chlorine.	Total solids.	Fixed solids.
Chester	0.30	2.90	1.45
Dover	0.35	2.00	...
Holderness	0.10	4.90	2.70
Keene	0.05	4.90	3.80
Temple	0.10	3.60	1.40
Whitefield	0.05	2.80	...

The water from Whitefield yielded a spectroscopic test for lithia in the solid residue; but it was not present in larger quantity than a distinct trace.

Wood Ashes

Three years ago Bulletin No. 43, "Some Inferior Wood Ashes," called attention to the fact that partially leached ashes were being sold in the state. Since that time we have received twenty-nine samples of ashes, of which nine were sent to the station in 1897, eleven in 1898, and nine this year.

Of these samples, but two showed evidences of having been leached. One of these was received last year and yielded only 2.38 per cent water-soluble potash and 3.82 per cent total potash. The other was received this fall and contained 1.67 per cent water-soluble potash and 1.94 per cent total potash.

The results obtained on all the samples are summarized as follows:

Digitized by Google

Phosphoric acid ranged from 1.01 per cent to 3.24 per cent. In twenty-two samples it was between 1.25 per cent and 1.75 per cent. Four samples gave results above 1.75 per cent, of which two were domestic ashes, with 2.65 per cent and 3.24 per cent respectively.

The potash soluble in water ranged from 1.67 per cent to 7.68 per cent. In fifteen samples it was between 4 per cent and 5 per cent; in seven samples between 5 and 6 per cent, and above 6 per cent in four. The total potash obtained by solution in hydrochloric acid ranged from 1.94 per cent to 10.15 per cent. In thirteen samples it was between 5 per cent and 6 per cent, in five between 6 and 7 per cent, and above 7 per cent in seven samples.

Respectfully submitted.

FRED W. MORSE,
Vice-Director and Chemist.

DEPARTMENT OF HORTICULTURE

The main lines of horticultural work at the station during the year have been with strawberries, muskmelons, tomatoes, grapes, and miscellaneous forcing crops under glass, reports upon which will be published in due time. Marked improvement has been made in our greenhouses. The old orchards have been placed under cultivation and preparations are being made for a larger planting of fruit trees the coming spring.

During the year three bulletins have been issued, viz., No. 60, "Green Corn under Glass"; No. 62, "Forcing Pole Beans under Glass," and No. 63, "Third Potato Report." If one may judge by the increased amount of correspondence, reports, and general conditions, the year has shown an increased interest in general horticulture throughout the state

Fruit Calendar for 1899

There have been comparatively few important matters to record for the past fruit season. Generally considered this

Digitized by Google

has been an off year, the extreme drouth of the early part of the season checking even the fruit that did set. Strawberries and other small fruits were more severely affected, perhaps, than the larger orchard fruits. Where it was possible to irrigate, or where the soil was of such a nature that it retained moisture, good crops were secured. Generally, however, they were cut very short. Not only was the crop small, but the season has been an exceptionally hard one in which to establish new plantations, and therefore a lack of similar fruit is liable to be felt next season.

It is generally considered that this has been the severest drouth we have had at this season of the year for the past generation. With our great variety of fruits, however, we find that what is harmful to one seems to favor another; the season was an ideal one for the grape. Reports from all sections go to show that not only was the crop very heavy but varieties which have heretofore been very indifferent, especially in ripening, matured this season and were exceptionally fine. The station vineyard, which is just coming into bearing, gave very fair returns, especially of the following varieties: Warden, Concord, Eaton, Early Ohio, Champion, Hartford, Ives' Seedling, Niagara, Brighton, Wyoming Red, Delaware, and Green Mountain. We anticipate giving a fuller report on the grape later.

The finest display seen this season in New Hampshire was the exhibit of Mr. J. E. Batchelder of Wilton, N. H., at Nashua. Mr. Batchelder exhibited at both the State Horticultural Society and the Nashua fair. His varieties were Moore's Early, Pocklington, Warden, Brighton, Cleveland, Salem, Niagara, Delaware, and Lindley. This exhibit was ideal throughout; fine, large, shouldered, and well-developed bunches containing large, well-colored berries characterized each plate. Grapes were plentiful and made a fine display at all of our fairs.

The orchard or tree fruits, especially the apple, varied more or less in different sections, some having practically none, while others produced a fair showing. Strange to say, even in the same section and orchard, a tree or part of a tree would

Digitized by Google

be heavily laden while others were barren. For this reason it has been a hard matter to estimate the season's returns. One tenth of a crop is perhaps a fair estimate for the apple crop. The writer observed when in Cheshire county this fall that every Blue Pearmain tree was loaded with fruit. It verily was a Pearmain year in this section; the fruit was large and perfect. Whether this observation holds true generally throughout the state is not known. This particular variety seems to be more commonly grown about Winchester than elsewhere. The only section reporting a full crop of apples was the southern portion of Carroll county.

Cherries were about as plentiful as usual. This fruit is sadly neglected generally, and the demand far exceeds the supply.

Pears were not plentiful but fairly supplied local demands at good prices.

Plums did not seem to be as abundant as usual, although a medium crop is reported generally. The largest yield was that of Mr. G. W. Parker of Wilton. Mr. Parker grew four hundred baskets, mostly of the Gueü variety. Damsons are, however, his best selling plums. He also fruited Burbanks, and is well pleased with them. The display of plums at the state grange fair was very good, the largest exhibitor being Mr. George F. Smith of Meredith. At the other fairs this exhibit was rather indifferent.

The peach crop we had thought a total failure until we found fair exhibits at Nashua and also at the Amesbury and Salisbury, Mass., fair. The display at Nashua was that of G. W. Parker of Wilton and consisted of excellent specimens of Oldmixon, Elberts, and Early Crawford. Mr. Parker tells me he had nearly one hundred baskets, which is a very small yield compared with that of last season. Last year he had upon two hundred Oldmixon trees alone eleven hundred baskets. The exhibit at the last named fair was that of Mr. Abraham Hilliard of Kensington, N. H. This display was also fine, consisting of two seedlings of marked value and the three varieties named above. Other peach growers report the

Digitized by Google

crop as a total failure. Mr. George Tuttle says that it was a difficult matter to find even a few to display this season. His is the orchard from which we reported over a thousand baskets last year.

While the fruit crop has been small, there nevertheless has seemed to be an awakening in fruit-growing which promises to result in a deeper interest. At the winter meeting of the state board of agriculture and the dairy convention held at the college last December, one day was set aside for discussing the growing of fruit. The summer meeting of the State Horticultural Society, known as "Strawberry day," which has grown in popularity the past few years, was well attended again this summer. The society and its friends met at the experiment station on June 29, under the auspices of the department of horticulture. Over one hundred varieties were displayed and partaken of, and after an informal meeting the visitors visited the strawberry patch, buildings, and grounds. The photograph, Fig. 53, shows a part of this gathering directly after lunch.

FRANK WM. RANE,
Horticulturist.

DEPARTMENT OF AGRICULTURE

During the past year the work of the department of agriculture has consisted of studies in an experimental way of some of the practical questions connected with agriculture.

Two divisions of work have been outlined: Animal Nutrition and Soil Physics.

In the first, the dairy herd, horses, and swine have been used in the studies. In the second, studies in soil improvement, soil moisture, physical treatment of soil, methods of applying manures, corn culture, clover culture, etc., have been made. These same lines of work will be continued during the coming year.

Digitized by Google

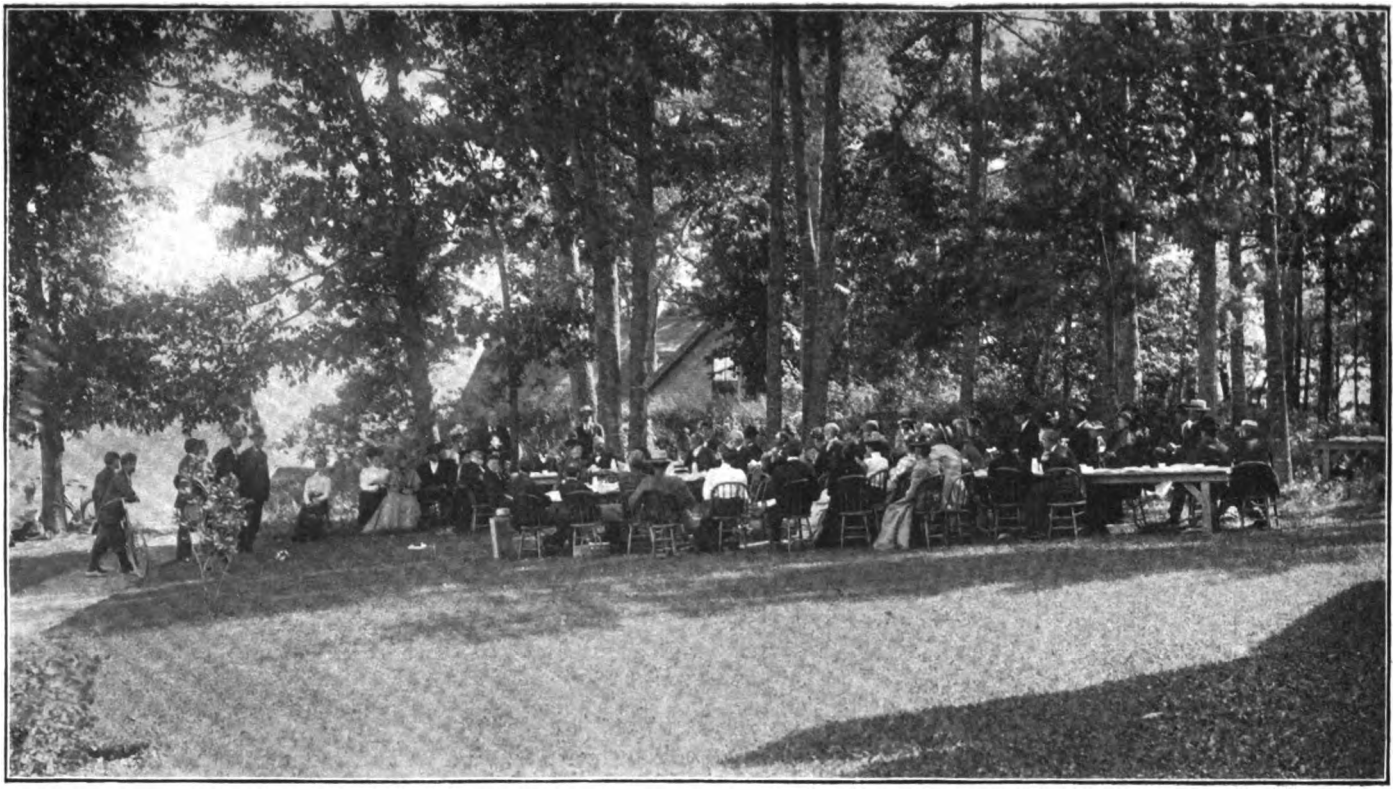


Fig. 53. "Strawberry day" at the Agricultural Experiment Station.

Digitized by Google

The College Herd

The college dairy herd at present consists of eighteen Jerseys, five pure-bred and thirteen grades, seven Ayrshires, three Guernseys, three grade Durhams, two grade Holsteins.

HERD RECORD FROM NOVEMBER 1, 1888, TO OCTOBER 31, 1889

Month.	Milch cows.	Dry cows.	Pounds of milk.	Average for each milch cow.	Average for herd.	Average fat test.	Pounds of butter.
November	25	7	10,603	424.1	27.3	4.6	575.33
December	27	5	13,141	486.7	33.8	4.5	696.93
January	25	8	14,719	588.7	37.9	4.9	824.26
February	30	2	14,400	480.0	37.1	4.5	756.88
March	28	5	15,155	541.2	39.0	4.8	866.38
April	27	6	13,654	505.7	35.1	4.7	748.54
May	28	5	14,852	530.4	38.2	4.2	727.74
June	25	7	13,549	361.7	34.9	4.7	724.08
July	27	5	13,957	516.5	35.9	4.5	725.47
August	24	8	14,124	588.5	36.1	4.0	650.27
September	28	4	14,152	505.4	36.4	4.6	759.48
October	29	3	14,422	497.3	37.1	4.8	800.21

The herd has been equivalent to 323 milch cows and 65 dry cows for one month, and has produced 166,728 pounds of milk and 8,864.57 pounds of butter, making an average monthly yield per head for 388 cows, 429 pounds of milk and 22.8 pounds of butter, or 5,148 pounds of milk and 273.6 pounds of butter for the year.

The data have been taken from the daily and weekly records of the barn and creamery, and the butter calculated by the standard formula, butter $= 1 + \frac{1}{6}$ fat, instead of the actual weights obtained, since the latter would involve corrections for milk and cream sold and fed to the calves.

Charles William Burkett,
Agriculturist.

Digitized by Google

DEPARTMENT OF ENTOMOLOGY

The work of the department of entomology during the year has followed closely along the lines of previous years. Realizing that the only way to obtain results of permanent value is to work continually and exhaustively upon the subjects selected for study, I have continued to confine our efforts to a comparatively few problems.

Two bulletins have been published by this department during the year. In April, Bulletin No. 64, treating of the Forest Tent Caterpillar, was issued to spread abroad a knowledge of this insect, which became exceedingly destructive in May and June. The October Bulletin (No. 67), treating of the Spiny Elm Caterpillar, was published to enlighten those interested concerning the life-history of, and remedies to be used against, this pest.

So much material has accumulated for the Insect Record of the year that it has been thought advisable to issue it as a separate bulletin rather than to incorporate it with this report, as has been done heretofore. A second bulletin upon the Forest caterpillar is also being prepared for publication this winter.

Studies of the life-history and parasites of both species of Tent Caterpillars have been continued through the season, as have the studies of several other injurious species, especially the Spiny Elm Caterpillar, the larva of the Mourning Cloak or Antiopa butterfly. With the assistance of Mr. Ned Dearborn, studies of the food of birds have also been continued, the species receiving special attention being the Ruffed Grouse, or "Partridge," and the Yellow-rumped Warbler. In the insect work I have had regularly the valued assistance of Mr. W. F. Fiske, and during the summer vacation Mr. R. A. Cushman added a large number of specimens to the insect collection. Most of the drawings for the entomological bulletins have been made by Mr. Joseph Bridgham.

CLARENCE M. WEED,
Entomologist.

Digitized by Google

DEPARTMENT OF BACTERIOLOGY

Since the last report this department has been working along the following lines:

Study of the bacteriology of ensilage. In this connection a series of experiments in taking temperatures in the silo by electrical means has been completed and another begun.

Study of the root tubercles of the leguminous plants.

Study and treatment of leaf and fruit spot of apple.

Study of life-history and treatment of black knot.

Study of the fungi and bacteria concerned in the decay of fruit with especial reference to the apple.

As an introduction to future bulletins the following summary of the principal general facts in regard to bacteria is here given:

Any one who gives the subject a moment's consideration cannot help being impressed by the wonderful variety of the plants which make up the grand division of living things known as the vegetable kingdom, but no one, who has not given special study to the subject, can have any adequate idea how great and how wonderful this variety is. Besides the plants which make up the greater part of the vegetation that clothes the earth's surface, and at the same time offer to man materials for food, clothing, houses, and innumerable luxuries, there are others which, while of the highest interest to the botanist or biologist, receive from the majority of people very little consideration, either because of their lack of economic importance or because of their small size, which renders them difficult of observation. Such plants are the mosses, the lichens, the algæ, and the fungi, which are considered to occupy a lower position in the scale of vegetable life than those with which we are most familiar. Lower still than these is a group of plants which, although the smallest members of the vegetable kingdom, are far from being the least important. Not only are they of interest to the botanist, but more and more it is coming to be recognized that they are of great economical and therefore of great practical importance. These plants are

Digitized by Google

the ones which are frequently spoken of as *germs, microbes,* or *micro-organisms,* and whose proper botanical name is *bacteria.* As has been intimated, the bacteria are the smallest plants of which we have any knowledge. Because of their extreme minuteness, their existence was not known until the microscope came as an aid and an extension to ordinary vision. After their discovery comparatively little information of importance in regard to their nature and function was acquired until the latter half of the present century.

The form and structure of bacteria are extremely simple, and show so little variety that, in appearance, different species

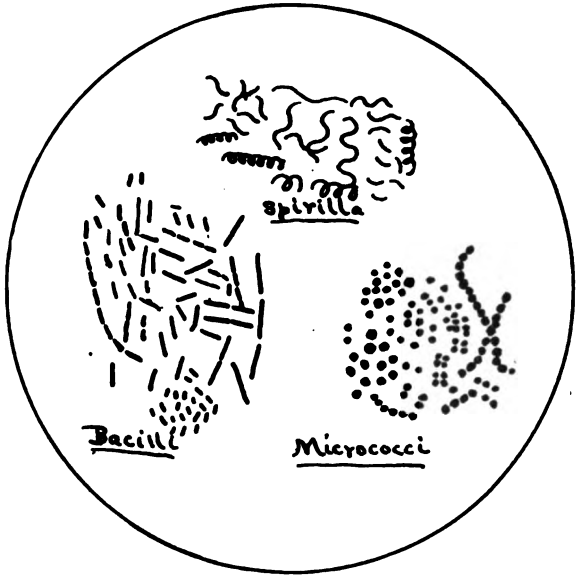


Fig. 54. Forms of Bacteria.

resemble one another very closely. Three principal forms are recognized: those which have the shape of little balls or spheres known as *micrococci*; those which are elongated and round, like a short pencil, known as *bacilli*; and those which are spiral or corkscrew-shaped known as *spirilla.* Fig. 54 shows the different forms as they appear under a moderately high power of

Digitized by Google

the microscope. Their size, though variable, is always very minute and even the highest powers of the microscope tell us but little in regard to their internal structure; therefore in studying bacteria and attempting to classify them, more attention is directed to what they do than to their form and structure; in other words, their physiological characteristics are of more importance than their anatomical ones.

The following are some of the more important facts in the life-history of the bacteria:

Size. They are so small that from ten to twenty-five thousand micrococci would be required to form a chain an inch long; from three to twenty thousand bacilli placed end to end would only aggregate the same length. In a mass no larger than the head of a pin there would be several millions of bacteria.

Distribution. Bacteria may be carried from place to place in various ways, but their chief means of distribution is by particles of dust floating in the air. They are found in the air, in water, in the soil, on all surfaces exposed to the air, and especially wherever decay is going on, being themselves the active agents in producing it.

Food. The food of bacteria consists of organic matter, that is, of substances that form a part or that have formed a part of some plant or animal.

Moisture. Bacteria can thrive only where there is moisture; while drying does not necessarily kill them, it completely checks their growth.

Oxygen. Some bacteria will grow only in the presence of oxygen; others only in its absence; while still others tolerate either condition.

Temperature. There is a certain temperature at which bacteria grow best; this varies in the different species, but for most lies somewhere between sixty and one hundred degrees Fahrenheit. As the temperature approaches the freezing point it becomes more and more unfavorable for them, and at or near that point all or nearly all cease to be active, though they may not be killed and may resume their activity when a higher

Digitized by Google

temperature is restored. As the temperature rises above one hundred it rapidly becomes unfavorable; different species have different resisting power, but all or nearly all perish after a few minutes' exposure somewhere between one hundred and twenty and two hundred and twelve, the temperature of boiling water. The spores which some species produce are much more resistant than the bacteria themselves; this fact has to be taken into account in using heat as a disinfectant.

Reproduction. The bacteria reproduce in a very simple way; a given microbe divides into two portions, each of which becomes an independent bacterium; these two in their turn produce two each, and so on indefinitely. When the conditions are favorable reproduction is very rapid, so that in the course of twenty-four hours the offspring of a single bacterium may number millions. In addition to this method some bacteria form special reproductive bodies called spores, which serve the same purpose as seeds in the higher plants. Spores retain their vitality under conditions that would kill the microbes themselves.

What is the role which bacteria play in nature? We know that plants and animals are continually dying; we also know that their bodies, after a longer or shorter period, disappear, leaving behind only a small amount of matter which finally becomes mixed with the soil, while the bulk of the substances composing them disappears as gases. None of these materials are lost, however, but somewhere and sometime they may and do enter into the composition of a new plant or animal. The chief agents in the production of this decomposition or decay of dead matter are the bacteria. They find in the dead organic matter the materials which serve them as food and when the other conditions are favorable they develop rapidly. As a result of their activity the original compounds are broken up and new ones are formed, usually simpler ones. These various changes are spoken of as fermentations; when they are accompanied by the production of foul odors, as in the decay of animal substances, the process is termed putrefaction. Some of the new substances are useful, others are harmless or indifferent, while still others are violent poisons.

Digitized by Google

Certain bacteria grow and flourish only under such conditions as are to be found in a living plant or animal; these are the parasitic or disease-producing bacteria. It is largely to the study of their relation to animal diseases that bacteriology owes its, in late years, rapid development. The disease-producing bacteria gain entrance to the animal body through the breathing or digestive apparatus or through wounds. In many cases when they gain entrance to the healthy body, though they find most of the conditions favorable to their development, they encounter a natural resistance which they are unable to overcome, and, as a consequence, perish without doing any serious damage. In other cases, owing to some unhealthy condition of the body in which the natural resistance is lost or weakened, the bacteria gain a foothold and develop, producing their characteristic disease. Tuberculosis or consumption, typhoid fever, diphtheria, cholera, lockjaw, anthrax, hog-cholera, and glanders are well-known examples of bacterial diseases.

While the farmer or housekeeper may never have seen bacteria, or may even be ignorant of their existence, yet they do things every day the fundamental reason for which has to do in some way with these tiny plants. Food, after it is cooked, if not used at once, is reheated or scalded after a few days "to keep it from spoiling"; the original cooking destroyed all or most of the bacteria present in the material; after twenty-four or forty-eight hours the few germs that may have been able to withstand the heat used, or new germs that may have fallen from the air, begin to develop, and would soon "spoil" the food if they were not killed by reheating. The essential thing in preserving fruit, meat, or other food by canning is to destroy by heat all bacteria present and by sealing up while hot to keep out any new ones. Food materials are kept in refrigerators because the low temperature produced by the ice is unfavorable to and retards the development of bacteria. The temperature of ordinary refrigerators, however, is not usually low enough to wholly check development, hence the things spoil after a time. The reason for the various applications of heat and cold in the dairy may readily be inferred. Corn and other

Digitized by Google

green fodder packed in the silo "keeps" because the packing excludes to a greater or less degree the oxygen of the air which is necessary for the development of the decay-producing bacteria. Certain substances, such as salt, sugar, smoke, are used to preserve food materials because they are unfavorable to the bacteria. The terms "pasteurization" and "sterilization" are frequently used in connection with the handling of various food products. A sterilized substance is one which has been subjected to a degree of heat, usually the boiling temperature, sufficient to kill all the bacteria and their spores which it may have originally contained. Many substances, *e. g.*, milk, cannot bear such a temperature without injury; a lower degree of heat, however, may be applied to them in such a way as to destroy most of the germs present, especially those likely to produce disease, without injury; this is pasteurization.

Anything which kills bacteria is a disinfectant. One of the best disinfectants is heat at the boiling temperature or higher. Besides heat certain chemical disinfectants are in frequent use, especially in dealing with disease germs; the most common are corrosive sublimate, formalin, carbolic acid, fumes of burning sulphur, and "chloride of lime." These are poisonous to animal life as well as to bacteria, and therefore must be used with care. A substance, which, while not necessarily fatal to bacteria, retards their growth, is called an antiseptic; sugar and salt, mentioned above, are such substances. Cold is to be considered as an antiseptic. Salicylic acid and boric acid are antiseptics which are sometimes used to preserve food; but any chemical food-preservative other than sugar and salt should be looked upon with suspicion as likely to be injurious to health.

Leaving out of account the disease-producing ones, bacteria are of great interest to those engaged in agriculture, from the intimate relation they sustain to many of the operations which are continually in progress on the farm, some of which have already been hinted at. In dairy work bacteria in great variety have to be dealt with; not only is the souring of the milk and the ripening of the cream due to their activity, but various other changes, desirable or the contrary, are brought about by

Digitized by Google

these omnipresent little plants. The milkman desires to suppress them entirely; the butter and cheese maker seeks to encourage the development of some species and to suppress that of others. In the manure pile myriads of bacteria are working, according to circumstances, rendering the contained plant-food more available on the one hand, or causing its loss on the other. In the soil they are working with the same variable result. Certain bacteria or bacteria-like plants grow on the roots of peas, clover, vetches, and related plants (the legumes), producing little nodules or tubercles; in some way they seem to enable the legumes to make use of a portion of the vast supply of nitrogen contained in the atmosphere, from which use most plants seem to be barred. As a more extended knowledge of the bacteria is acquired, it is more than possible that we shall be able to control their activity where heretofore it has been left to chance with variable result.

H. H. LAMSON,
Bacteriologist.

DEPARTMENT OF METEOROLOGY AND AGRICULTURAL ENGINEERING

I. METEOROLOGY

Observations have been continued as during previous years with Charles T. Staniels, New Hampshire College, class of 1901, acting as observer during most of the year.

Signal flags have been displayed each day, except Sundays and holidays, throughout the year from the tower of the experiment station building, indicative of the weather for the succeeding night and day. In addition a synopsis of weather conditions has been written each day upon the blackboard at the station building for the benefit of the station workers.

A Draper self-recording thermometer has been added to the equipment, and it has proved very useful in checking the maximum and minimum daily readings, as well as in other ways. A wet bulb thermometer to indicate the humidity of the air has also been procured, and its readings taken during the growing season from April to November.

Digitized by Google

The excessive rainfall of the past few years continued till April 1, 1899. At that time the soil was thoroughly saturated with moisture and all springs were running full. Then came a sudden change, and the last three months of the year were abnormally dry, with a total precipitation of only 3.6 inches. Indeed this lack of rain was the chief feature of the weather for the year, and had a marked effect upon farm crops, especially grass, the amount of hay harvested in this vicinity being about one half of that of the previous year. Hoed crops on heavy soil did not suffer seriously.

The year was rather remarkable for a lack of extremes in temperature, leaving the average about normal. No excessive hot spells in summer or cold in winter were registered. No killing frost occurred till October 10, vegetation holding green in general till that date.

October was the month of largest rainfall, in striking contrast to the previous year when it was the driest month. Winter started in early with a heavy snowfall in November, but the snow did not last for sleighing. The total snowfall was about the same as for the previous year. Thunder storms were numerous through the summer season, but no remarkable storms of any kind were registered either in summer or winter.

II. Agricultural Engineering

The college steam drill has been in use twice during the year and these occasions were utilized for class instruction in road building. Practical instruction was also given in the use of the derrick. A survey was made by the class in roads with the aid of the grade level and chain, of a proposed change of location of a public road for the improvement of its grade.

Through the kindness of the Climax Road Machine Company, a complete plant for elevating and screening gravel was placed at the disposal of the writer for experimental road work. The machine has been set up at the gravel bank near the reservoir. It was found necessary to make changes in the screening apparatus in order to obtain the best results, and experiments are still going forward which later will be reported in detail in bulletin form.

Digitized by Google

A somewhat extensive permanent improvement has been nearly completed upon the westerly end of the land assigned to the experiment station. The brook there was very winding and the land near it too wet for general cultivation. The brook has been straightened and deepened for some five hundred feet in length, and the land on either side has been sloped with an easy grade, the soil thus obtained being used to fill the low ground and the former bed of the brook. The result is the securing of two fields, one on either side of the brook, of even surface and deep soil, suitable for almost any farm purpose, where before nothing but swale grass and alder bushes grew. The same method of improvement may be applied later with advantage to the easterly half of the same field.

In May, 1899, a paper on "Road Drainage" was read before the state road convention at Lancaster, N. H., and talks on kindred subjects were given at other places during the year.

C. H. PETTEE,
Meteorologist.

Digitized by Google

METEOROLOGICAL TABLES

Digitized by Google

METEOROLO..

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE Lat. ,

July, 1888.	8 A.M.		8 P.M.		TEMPERATURE.							
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Mean
1	75.	29.588	80.	29.844	69.	76.	72.5	.....	.....	85.	54	6
2	80.	29.966	78.	29.842	73.	68.	70.5	.....	.....	85.	56.	7
3	89.	29.746	91.	29.620	80.	87.	83.5	.....	.....	98.	65.	8
4	92.	29.606	84.	29.6	84.	78.	81.	.....	.....	93.	73	8
5	90.	29.838	75.	29.908	68.	64.	66.	.....	.....	78.	61	6
6	74.	30.02	80.	29.966	66.	65.	65.5	.....	.....	71.	60.	6
7	75.	29.928	78.	29.802	69.	66.	67.5	.....	.....	82.	59.	7
8	78.	29.670	85.	29.494	73.	77.	75.	.....	.....	90.	62.	7
9	80.	29.414	80.	29.502	72.	65.	75.5	.....	.....	82.	67.	7
10	70.	29.596	70.	29.712	65.	61.	63.	.....	58.5	69.	59	6
11	73.	29.884	70.	29.984	65.	58.	68.5	55.	56.	71.	54	6
12	68.	30.172	70.	30.178	60.	58.	59.	55.	56.	68.	52	5
13	65.	30.1	65.	29.938	55.	56.	55.5	55.	56.	59.	53.	5
14	73.	29.94	78.	29.722	67.	67.	67.	64.	67.	85.	55	7
15	76.	29.51	80.	29.608	74.	72.	73.	70.	62.	83.	65.	7
16	82.	29.648	80.	29.792	72.	72.	72.	61.	57.	82.	62	7
17	80.	29.8	76.	29.776	71.	66.	68.5	60.	.....	81.	54.	6
18	77.	29.832	80.	29.788	70.	71.	70.5	64.	69.5	80.	60.	7
19	78.	29.718	85.	29.702	73.	77.	75.	71.	72.	87.	62	7
20	82.	29.692	84.	29.652	77.	75.	76.	72.	73.	85.	72.	7
21	79.	29.704	80.	29.752	71.	70.	70.5	71.	68.	85.	66.	7
22	77.	29.918	77.	29.953	70.	67.	68.5	66.	59.	80.	65.	6
23	76.	30.022	75.	29.962	67.	63.	65.	65.	58.	78.	55.	6
24	65.	29.934	75.	29.910	63.	65.	64.	59.	60.	80.	61	6
25	72.	29.862	75.	29.732	67.	72.	69.5	66.	68.	75.	62.	6
26	75.	29.698	78.	29.73	71.	72.	71.5	70.	70.	78.	66.	7
27	75.	29.724	76.	29.751	67.	67.	67.	67.	67.	81.	58.	6
28	73.	29.582	77.	29.613	66.	65.	65.5	66.	64.	78.	64	6
29	75.	29.600	85.	29.553	72.	78.	75.	70.	77.	90.	68.	7
30	85.	29.622	83.	29.636	83.	74.	78.5	80.	72.	95.	69.	8
31	75.	29.714	72.	29.704	72.	67.	69.5	65.	65.	78.	67.	7
Sum ...	.....	.....	.....	.....	2172.	2149.	2169.5	.....	.....	2518.	1873.	
Mean.	.....	.....	.....	.....	70.+	69.3+	70—	.....	.....	81.2+	60.6—	

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

July, 1898.	Precipitation. Time of beginning.	Precipitation. Time of ending.	Precipitation. Total amount in inches.	Precipitation. Snowfall in inches.	Prevailing wind direction.	Character of day.	Remarks.
1					S. E.	Clear.	Maximum temperature, 98; date, 3d.
2					S. E.	Clear.	
3					S. W.	Clear.	Minimum temperature, 48; date, 11th.
4					N. W.	Clear.	
5					S. E.	Clear.	Mean temperature (mean max.+mean min.÷2), 70.8.
6					S. E.	Clear.	
7					S. E.	Clear.	
8					S. W.	Clear.	Mean temperature (8+8÷2), 70.
9	Showers.		.02		S. E.	Partly cloudy.	
10					S. E.	Partly cloudy.	Mean max. temperature, 81.2; mean min. temperature, 60.6.
11	During night.				S. E.	Partly cloudy.	
12		During night.	.84		E.	Partly cloudy.	Total precipitation, 1.75 inches.
13					E.	Cloudy.	
14					S. E.	Clear.	Greatest precipitation in any 24 consecutive hours, .84; date, 11th and 12th.
15					N. W.	Partly cloudy.	
16					N. W.	Clear.	
17	During night.				S. E.	Partly cloudy.	Number of clear days, 12; partly cloudy, 14; cloudy, 5; on which .01 or more precipitation fell, 9.
18		During night.	.06		S. E.	Partly cloudy.	
19					S. W.	Partly cloudy.	
20					S. E.	Partly cloudy.	
21	3 p. m.	6 p. m.	.73		W.	Partly cloudy.	Prevailing wind direction, S. E. 21st, heavy thunder storm in p. m.
22					S. E.	Partly cloudy.	
23	8 a. m.				S. E.	Cloudy.	
24		During night.	.07		S. E.	Clear.	
25					S.	Cloudy.	
26	Showers.		.02		S.	Partly cloudy.	
27					S. E.	Cloudy.	
28	Showers.		.01		S.	Cloudy.	
29					S. E.	Partly cloudy.	
30	Showers.		.01		S. W.	Partly cloudy.	
31					E.	Clear.	
Sum...			1.75				

Digitized by Google

METEOROLO

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. Lat.

August, 1888.	8 A. M.		8 P. M.		TEMPERATURE.							
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Range.
1	71.	29.822	72.	29.776	67.	66.	66.5	64.	65.5	72.	62.	10.
2	76.	29.714	79.	29.760	73.	74.	73.5	71.	65.	85.	66.	19.
3	79.	29.812	78.	29.754	76.	71.	73.5	72.	69.5	84.	62.	22.
4	77.	29.714	85.	29.636	71.	80.	75.5	69.	79.5	88.	68.	20.
5	76.	29.636	76.	29.666	68.	68.	67.	68.	62.5	74.	66.	8.
6	75.	29.738	75.	29.670	67.	71.	69.	60.	65.	82.	58.	24.
7	78.	29.652	80.	29.636	71.	73.	72.	64.	67.	85.	59.	26.
8	77.	29.590	80.	29.562	72.	77.	74.5	71.	74.5	87.	66.	21.
9	79.	29.578	88.	29.662	72.	74.	73.	69.	70.	84.	69.	15.
10	73.	29.666	67.	29.752	67.	61.	64.	63.	61.	68.	61.	7.
11	65.	29.736	65.	29.772	63.	64.	63.5	62.	61.	69.	60.	9.
12	72.	29.802	.....	.....	68.	65.	66.5	63.	.....	72.	61.	11.
13	71.	29.744	75.	29.330	67.	64.	65.5	66.5	61.	82.	61.	21.
14	70.	29.722	74.	29.956	65.	66.	65.5	62.5	62.	83.	56.	27.
15	71.	29.964	73.	29.918	67.	66.	66.5	64.5	63.	80.	54.	26.
16	71.	29.812	82.	29.712	65.	76.	70.5	62.	72.	85.	55.	30.
17	77.	29.662	80.	29.650	71.	76.	73.5	68.5	73.	87.	58.	29.
18	78.	29.606	72.	29.692	73.	71.	72.	69.	69.5	85.	62.	23.
19	69.	29.680	68.	29.640	66.	65.	65.5	65.	63.	68.	56.	12.
20	60.	29.740	70.	29.710	65.	72.	63.5	63.	61.	70.	56.	14.
21	69.	29.691	73.	29.642	66.	73.	69.5	65.	72.	86.	56.	30.
22	77.	29.572	83.	29.552	73.	76.	74.5	68.	72.	88.	59.	29.
23	78.	29.606	78.	29.536	74.	67.	75.5	70.	67.	87.	65.	22.
24	80.	29.562	78.	29.584	79.	69.	74.	73.	69.	92.	65.	27.
25	76.	29.530	79.	29.464	69.	71.	70.	68.5	69.5	82.	65.	17.
26	80.	29.494	71.	29.584	68.	63.	65.5	62.	57.	78.	60.	18.
27	72.	29.676	68.	29.804	62.	62.	62.	53.	56.	70.	50.	20.
28	68.	29.978	72.	29.934	52.	64.	58.	55.	64.	82.	44.	38.
29	68.	29.888	68.	29.742	58.	61.	59.5	58.5	67.5	70.	47.	23.
30	70.	29.716	76.	29.712	61.	71.	66.	62.5	70.	73.	53.	20.
31	70.	29.692	72.	29.714	65.	74.	69.5	.....	.....	85.	61.	24.
Sum....	.....	.....	.....	.....	2101.	2150.	2125.	.....	.....	2483.	1846.	637.
Mean..	.....	.....	.....	.....	67.7+	69.6+	68.5	.....	.....	80.0+	59.6	20.5+

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

August, 1888.	Precipitation. Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.	Prevailing wind direction.	Character of day.	Remarks.
1	Showers.		*	.....	S. E.	Cloudy.....	Maximum temperature, 92; date, 24th.
2	.....	.....	.....	.....	S. W.	Clear.....	
3	.....	.....	.....	.....	S. E.	Partly cloudy..	Minimum temperature, 44; date, 28th.
4	During night.		.26	.....	S. E.	Partly cloudy..	
5	During night.	12 m.	1.28	.....	E.	Partly cloudy..	Mean temperature (mean max. + mean min. ÷ 2), 69.8.
6	.....	.....	.....	.....	S. E.	Partly cloudy..	
7	.....	.....	.....	.....	W.	Clear.....	
8	During night.	8.30 a. m.	.19	.....	S. W.	Partly cloudy..	Mean temperature (8 + 8 ÷ 2), 68.7.
9	During night.		.05	.....	S. E.	Partly cloudy..	Mean max. temperature, 80; mean min. temperature, 59.6.
10	.....	.....	.....	.....	E.	Cloudy.....	
11	During night.	9 a. m.	.65	.....	N. E.	Cloudy.....	Total precipitation, 5.92 inches.
12	Showers.		.02	.....	E.	Cloudy.....	
13	Showers.		.05	.....	W.	Partly cloudy..	Greatest precipitation in any 24 consecutive hours, 1.28; date, Aug. 5.
14	.....	.....	.....	.....	S. E.	Partly cloudy..	
15	6 a. m.	.....	*	.....	S. E.	Clear.....	
16	.....	.....	.....	.....	S.	Partly cloudy..	No. of clear days, 9; partly cloudy, 15; cloudy, 7; on which .01 or more precipitation fell, 12.
17	.....	.....	.....	.....	S. W.	Clear.....	
18	.....	.....	.....	.....	S.	Partly cloudy..	
19	8 a. m.	8 p. m.	1.19	.....	N. W.	Cloudy.....	Prevailing wind direction, S. W.
20	During night.		.02	.....	S. E.	Partly cloudy..	
21	.....	.....	.....	.....	N. E.	Partly cloudy..	
22	.....	.....	.....	.....	S. W.	Partly cloudy..	
23	6 p. m.	8 p. m.	1.10	.....	S. W.	Partly cloudy..	
24	6 p. m.	During night.	.55	.....	S. W.	Partly cloudy..	23d, 24th, and 25th, heavy thunder showers. Damage by lightning on 23d, and by wind on 25th.
25	Showers.		.56	.....	S. W.	Cloudy.....	
26	.....	.....	.....	.....	W.	Clear.....	
27	.....	.....	.....	.....	W.	Clear.....	
28	.....	.....	.....	.....	W.	Clear.....	
29	.....	.....	.....	.....	S. W.	Cloudy.....	
30	.....	.....	.....	.....	S. W.	Clear.....	
31	.....	.....	.....	.....	W.	Clear.....	
Sum...	.....	.....	5.92	.....			
.....	.....	.....	.....	.....			

* Trace.

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° 1'

September, 1898.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Departure.
1	78.	29.788	80.	29.752	76.	73.	74.5	83.	68.	73.5	11
2	80.	29.724	78.	29.476	73.	68.	70.	79.	65.	72.5	14
3	80.	29.484	78.	29.632	77.	68.	72.5	88.	63.	75.5	17
4	75.	29.666	78.	29.588	63.	75.	69.	81.	61.	71.	3
5	79.	29.624	80.	29.604	79.	70.	72.	85.	66.	75.5	11
6	76.	29.644	70.	29.632	73.	68.	70.5	86.	63.	74.5	11
7	80.	29.556	76.	29.522	74.5	67.	70.5	89.	63.	76.	8
8	71.	29.840	70.	29.916	73.	59.	61.	80.	55.	67.5	3
9	68.	30.013	71.	30.008	62.	61.	61.5	78.	49.	63.5	5
10	65.	29.921	67.	29.976	58.	59.	58.5	77.	47.	62.	4
11	60.	29.914	65.	29.890	53.	54.5	53.5	79.	42.	60.5	2
12	63.	29.902	60.	30.084	57.	51.5	54.	68.	47.	57.5	1
13	63.	30.246	66.	30.020	52.	57.	54.5	72.	38.	55.	4
14	64.	29.910	66.	29.920	55.	55.	55.	74.	40.	57.	2
15	62.	29.844	67.	29.822	53.	62.	57.5	69.	42.	55.5	3
16	66.	29.742	60.	29.660	62.	65.	63.5	74.	58.	66.	16
17	72.	29.688	72.	29.506	69.	63.	66.	81.	61.	71.	26
18	68.	29.626	72.	29.492	60.	61.	60.5	81.	50.	65.5	24
19	71.	29.524	68.	29.594	63.	55.	59.	70.	57.	63.5	12
20	64.	29.644	60.	29.824	54.	49.	51.5	62.	45.	53.5	1
21	59.	30.030	58.	29.994	47.	49.	48.	64.	38.	51.	5
22	62.	29.926	60.	29.804	52.	62.	57.	74.	42.	58.	2
23	64.	29.520	62.	29.494	59.	64.	61.5	76.	58.	67.	12
24	61.	29.518	54.	29.854	50.	46.	48.	49.	49.	49.	...
25	52.	29.848	54.	29.752	46.	50.	48.	54.	44.	49.	1
26	59.	29.618	60.	29.434	56.	56.	56	71.	50.	60.5	1
27	60.	29.348	59.	29.577	56.	51.	53.5	61.	48.	54.5	5
28	68.	29.718	68.	29.804	54.	52.	53.	70.	46.	58.	1
29	61.	29.810	70.	29.816	49.	63.	56.	77.	40.	58.5	1
30	70.	29.914	70.	29.864	59.	60.	59.5	77.	48.	62.5	3
Sum					1811.	1794.	1795.5	2229.	1343.	1875.	66
Mean					60.3+	59.8	59.8	74.3	51.4	62.5	2.2

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

September, 1888.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.			
1					S. W.	Partly cloudy..	Maximum temperature, 89; date, 7th.
2	7.15 p. m.	9 p. m.	.12		W.	Partly cloudy..	
3					W-E	Clear.....	Minimum temperature, 38; date, 13th and 21st.
4	7.30 p. m.				S. W.	Cloudy.....	
5		During night.	.06		S. E.	Partly cloudy..	Mean temperature (mean max. + mean min.÷2), 62.8.
6					S.	Clear.....	
7	2.30 p. m.				S.	Partly cloudy..	
8		During night.	1.21		S. E.	Clear.....	Mean temperature (8+8÷2), 60.1.
9					S.	Clear.....	Mean max. temperature, 74.3; mean min. temperature, 51.4.
10					S. W.	Clear.....	
11					W.	Clear.....	
12					S. W.	Clear.....	
13					S.	Partly cloudy..	Total precipitation, 3.57 inches.
14					S.	Partly cloudy..	
15					S. E.	Cloudy.....	Greatest precipitation in any 24 consecutive hours, 1.21; date, 8th.
16					S. E.	Partly cloudy..	
17					N.	Clear.....	
18					S. W.	Partly cloudy..	
19	During night.		.18		W.	Cloudy.....	No. of clear days, 14; partly cloudy, 10; cloudy, 6; on which .01 or more precipitation fell, 7.
20					N. W.	Partly cloudy..	
21					W.	Clear.....	
22					S. W.	Partly cloudy..	
23					N. E.	Cloudy.....	
24	During night.	10 a. m.	.18		N. E.	Cloudy.....	Prevailing wind direction, W. and S. W.
25	6 p. m.	During night.	1.06		E.	Cloudy.....	Dates of frost, *very light* on 13th; light on 21st.
26					W.	Clear.....	
27	During night.		.76		N.	Clear.....	Evening of 2d, much lightning, little rain.
28					N. W.	Clear.....	
29					W.	Clear.....	Evening of 4th, much lightning, little rain.
30					.....	Clear.....	
							Afternoon of 7th, three heavy thunder showers in succession, clearing between each; gentle rain after last one into night.
Sum		.....	3.57				

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. Lat. 43°

October, 1898.	8 A. M.		8 P. M.		TEMPERATURE.							
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Range.
1	69.	30.002	73.	30.200	62.	65.	63.5	59.	63.	71.	54.	17.
2	65.	30.146	68.	30.028	61.	55.	58.	59.	55.	70.	54.	16.
3	67.	29.980	75.	29.864	57.	72.	64.5	57.	69.	68.	53.	15.
4	74.	29.840	77.	29.880	72.	71.	71.5	69.	70.	84.	57.	27.
5	68.	29.842	65.	29.754	55.	53.	54.	53.	53.	83.	52.	31.
6	67.	29.900	66.	30.140	54.	43.	48.5	46.	41.	62.	43.	19.
7	67.	30.144	64.	30.020	47.	54.	50.5	44.	51.	60.	34.	26.
8	67.	29.880	68.	29.064	50.	54.	52.	49.	54.	64.	40.	24.
9	65.	29.702	66.	29.846	51.	48.	49.5	47.	42.	58.	43.	15.
10	58.	30.182	60.	29.922	40.	42.	41.	36.	40.	63.	29.	34.
11	56.	29.986	69.	29.568	47.	61.	54.	46.	59.	55.	36.	19.
12	65.	29.442	65.	29.504	58.	53.	55.5	57.	47.	69.	41.	28.
13	65.	29.720	62.	29.744	46.	45.	45.5	41.	44.	70.	36.	34.
14	59.	29.800	59.	29.646	45.	49.	47.	43.	46.	58.	38.	20.
15	57.	29.404	60.	29.422	48.	42.	45.	47.	37.	54.	42.	12.
16	58.	29.620	52.	29.842	42.	40.5	41.2	36.	40.	50.	36.	14.
17	59.	29.984	58.	30.048	39.	39.	39.	35.	36.	49.	32.	17.
18	59.	30.006	59.	30.040	35.	36.	35.5	35.	35.	51.	29.	22.
19	59.	30.020	59.	29.806	46.	49.5	47.7	42.	49.	48.	32.	16.
20	62.	29.884	62.	29.946	50.	52.	51.	48.	50.	51.	44.	7.
21	58.	29.900	62.	29.840	41.	48.	44.5	40.	48.	65.	42.	23.
22	61.	29.300	69.	29.188	57.	66.	61.5	57.	65.	62.	46.	16.
23	61.	29.418	60.	29.804	50.	48.	49.	45.	44.	68.	46.	22.
24	60.	30.018	63.	30.000	47.	52.	49.5	44.	48.	59.	39.	20.
25	68.	30.000	65.	29.920	44.	52.	48.	43.	51.	65.	39.	26.
26	62.	29.800	67.	29.426	57.	62.5	59.7	56.	62.	62.	47.	15.
27	65.	29.428	65.	29.792	48.	39.	43.5	44.	34.	65.	38.	27.
28	61.	30.022	63.	30.106	36.	34.	35.	35.	33.	52.	30.	22.
29	60.	30.102	62.	29.950	38.	44.	41.	35.	44.	48.	30.	18.
30	.....	.....	.....	.....	44.	45.	44.5	43.	45.	45.	41.	4.
31	.....	.....	.....	.....	37.	41.	39.	36.	38.	50.	28.	22.
Sum	.....	.....	.....	.....	1504.	1553.5	1530.6	.....	.....	188.9	126.	12
Mean	.....	.....	.....	.....	48.5	50.2	49.4	.....	.....	60.9	41.2	2

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

October, 1886.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.			
1	.....	.....	.....	.....	E.	Clear.	Maximum temperature, 84; date, 4th.
2	.....	.....	.....	.....	S. W.	Partly cloudy.	
3	.....	.....	.....	.....	S. W.	Partly cloudy.	Minimum temperature, 29; date, 10th and 18th.
4	.....	.....	.....	.....	W.	Partly cloudy.	
5	During night.		.....	.....	N.E.	Cloudy.	
6	.....	.....	2.01	.....	N.W.	Clear.	Mean temperature (mean max.+mean min.÷2), 51.05.
7	10 a. m.	.....	.53	.....	S.	Partly cloudy.	
8	.....	10 a. m.	.02	.....	W.	Cloudy.	
9	.....	.....	.....	.....	W.	Clear.	Mean temperature (8+8÷2), 49.3.
10	.....	.....	.....	.....	S. W.	Clear.	
11	.....	.....	.....	.....	S. W.	Clear.	Mean max. temperature, 60.9; mean min. temperature, 41.2.
12	During night.		.15	.....	W.	Partly cloudy.	
13	.....	.....	.....	.....	W.	Partly cloudy.	
14	.....	.....	.....	.....	N.	Cloudy.	
15	Night.		1.1	.....	N.W.	Cloudy.	Total precipitation, 7.62 inches.
16	.....	.....	.....	.....	N.W.	Clear.	
17	.....	.....	.....	.....	N.E.	Clear.	Greatest precipitation in any 24 consecutive hours, 2.01; date, 6th.
18	.....	.....	.....	.....	S. E.	Partly cloudy.	
19	1 p. m.	.....	.....	.....	N.E.	Cloudy.	
20	.....	During night.	1.08	.....	N.E.	Cloudy.	Number of clear days, 8; partly cloudy, 12; cloudy, 11; on which .01 or more precipitation fell, 10.
21	Night.	.....	.....	.....	E.	Cloudy.	
22	.....	3 p. m.	1.37	.....	S.	Cloudy.	
23	.....	.....	.....	.....	W.	Partly cloudy.	
24	.....	.....	.....	.....	S.	Partly cloudy.	Prevailing wind, W. S. W.
25	.....	.....	.....	.....	S.	Partly cloudy.	
26	8.30 a. m.	7 p. m.	1.22	.....	S.	Cloudy.	
27	.....	.....	.....	.....	S.	Partly cloudy.	
28	.....	.....	.....	.....	S. E.	Clear.	Dates of frost, 7th and 10th.
29	9 a. m.	.....	.....	.....	S.	Cloudy.	
30	.....	10 p. m.	.14	.....	S.W.	Cloudy.	
31	.....	.....	.....	.....	S.W.	Partly cloudy.	
Sum ...	.....	.....	7.62				
.....	.....	.....	.....				

Digitized by Google

METEOROLOG

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT 4

November, 1888.	8 A. M.		8 P. M.		TEMPERATURE.							
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Mean
1	68.	29.940	66.	30.012	40.	39.	39.5	36.	37.	50.	34.	
2	60.	29.842	61.	29.904	44.	48.	46.	42.	45.	52.	34.	
3	63.	30.120	60.	30.134	43.	41.	42.	38.	38.	61.	38.	
4	64.	30.218	66.	30.112	39.	41.	40.	46.	40.5	61.	38.	
5	62.	30.002	66.	29.700	36.	49.	42.5	36.	49.	58.	27.	
6	64.	29.264	58.	29.314	59.	45.	52.	59.	45.	59.	43.	
7	57.	29.596	60.	29.916	40.	35.	37.5	35.5	34.	59.	35.	
8	55.	29.982	58.	29.894	31.	48.	37.5	32.	42.	43.	28.	
9	59.	29.960	66.	30.026	45.	48.	46.5	42.	45.	60.	43.	
10	56.	29.982	55.	29.420	34.	34.	34.	34.	34.	59.	31.	
11	56.	29.300	54.	29.024	36.	35.	35.5	36.	31.	37.	35.	
12	55.	29.922	62.	29.960	32.	33.	32.5	27.	29.	45.	25.	
13	57.	29.950	54.	29.744	28.	45.	36.5	32.	44.	44.	22.	
14	55.	29.500	59.	29.508	41.	39.	40.	41.	36.	50.	30.	
15	61.	29.814	64.	29.872	34.	39.	36.5	32.	36.	48.	22.	
16	62.	29.970	70.	29.944	39.	40.	39.5	36.	35.	47.	36.	
17	59.	30.000	65.	29.872	38.	45.	41.5	37.	44.	48.	31.	
18	60.	29.750	69.	29.574	44.	42.	43.	44.	42.	46.	41.	
19	58.	29.230	64.	28.972	40.	43.	41.5	39.	43.	46.	39.	
20	56.	29.226	50.	29.508	44.	40.	42.	39.	35.	45.	37.	
21	55.	29.344	58.	29.988	37.	37.	37.	34.	34.	46.	34.	
22	59.	29.982	58.	29.856	34.	32.	33.	32.	31.	56.	30.	
23	58.	29.764	65.	29.772	35.	45.	40.	34.	42.	47.	31.	
24	55.	29.790	52.	29.580	37.	37.	37.	36.	37.	49.	34.	
25	58.	29.544	49.	29.754	30.	18.	24.	.....	.....	43.	25.	
26	52.	29.830	54.	29.650	18.	27.	22.5	.....	.....	32.	15.	
27	36.	29.192	37.	29.240	27.	27.	27.	.....	.....	27.	23.	
28	45.	29.354	52.	29.432	26.	28.	27.	.....	.....	29.	18.	
29	53.	29.368	55.	29.254	24.	26.	25.	.....	.....	34.	22.	
30	45.	28.940	52.	29.112	30.	32.	31.	.....	.....	40.	24.	
Sum	.....	.....	.....	.....	1085.	1138.	1111.5	.....	.....	1421.	939.	1180.
Mean	.....	.....	.....	.....	36.1	37.9	37.	.....	.....	47.3	31.3	39.3

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

November, 1898.	PRECIPITATION.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.			
1	.....	.....	.....	.....	S. E.	Clear	Maximum temperature, 61; date, 3d and 4th.
2	.....	.....	.....	.....	S. W.	Clear	
3	.....	.....	.....	.....	S.	Clear	
4	.....	.....	.....	.....	S. E.	Partly cloudy..	Minimum temperature, 15; date, 26th.
5	Night.	8 a. m.	.02	.....	S. E.	Cloudy	
6	Night.	.....	.....	.....	S. E.	Cloudy	Mean temperature (mean max. + mean min. ÷ 2), 39.3.
7	.....	Night.	.10	.....	W.	Clear	
8	.....	.....	.....	.....	W.	Clear	
9	Night.	.....	.....	.....	E.	Partly cloudy..	
10	.....	12 p. m.	1.57	½	N.	Cloudy	Mean temperature (8+8÷2), 37.
11	.....	.....	.....	.....	N. E.	Cloudy	
12	.....	.....	.....	.....	W.	Partly cloudy..	Mean max. temperature, 47.3; mean min. temperature, 31.3.
13	10.45 p. m.	.....	.....	.....	S.	Partly cloudy..	
14	.....	6 a. m.	.18	.....	N. W.	Cloudy	Total precipitation, 5.17 inches.
15	.....	.....	.....	.....	S. W.	Clear	
16	.....	.....	.....	.....	N. W.	Cloudy	
17	11.45 a. m.	6 p. m.	.33	.....	E.	Cloudy	Greatest precipitation in any 24 consecutive hours, 1.57; date, 10th.
18	9 a. m.	.....	.....	.....	N. E.	Cloudy	
19	.....	11 p. m.	1.26	.....	N. W.	Cloudy	
20	.....	.....	.....	.....	N. W.	Partly cloudy..	
21	.....	.....	.....	.....	N.	Clear	Total snowfall during the month, 15½ inches.
22	.....	.....	.....	.....	N.	Partly cloudy..	
23	.....	.....	.....	.....	N. W.	Partly cloudy..	
24	11 a. m.	Night.	.41	.....	N.	Cloudy	
25	.....	.....	.....	.....	W.	Partly cloudy..	No. of clear days, 7; partly cloudy, 12; cloudy, 11; on which .01 or more precipitation fell, 10.
26	Night.	.....	.....	.....	N.	Partly cloudy..	
27	.....	.....	.....	.....	N. W.	Cloudy	
28	.....	11 p. m.	1.3	15.	N. W.	Partly cloudy..	Prevailing wind direction, N. W.
29	.....	.....	.....	.....	S. W	Partly cloudy..	
30	.....	.....	.....	.....	W.	Partly cloudy..	Very hard snowstorm and high wind on the 27th and 28th.
							First snow fell on the 10th, about ½ inch.
Sum ...	.....	....	5.17	15.5			
.....	.....	.....	.....				

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° 8′ N.

December, 1898.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	58.	29.324	60.	29.058	32.	30.	31.	34.	29.	31.5	5.
2	55.	29.702	65.	29.884	28.	28.	28.	37.	25.	31.	12.
3	57.	29.900	62.	29.978	19.	32.	25.5	41.	27.	34.	14.
4	50.	29.972	45.	29.660	32.	36.	34.	39.	31.	35.	8.
5	51.	28.976	61.	29.042	39.	35.	37.	44.	34.	39.	10.
6	54.	29.456	60.	29.622	32.	30.	31.	44.	30.	37.	14.
7	58.	29.540	59.	29.656	28.	27.	27.5	38.	26.	32.	12.
8	50.	29.732	58.	29.800	21.	26.	23.5	38.	20.	29.	18.
9	46.	29.856	57.	29.760	14.	18.	16.	31.	11.	21.	20.
10	52.	29.488	58.	29.301	27.	27.	27.	27.	16.	21.5	11.
11	50.	29.076	45.	29.086	29.	27.	28.	32.	24.	28.	8.
12	47.	29.420	46.	29.246	16.	16.	16.	34.	15.	24.5	19.
13	48.	29.482	51.	29.834	14.	01.	25.	18.	01.	09.5	17.
14	46.	30.100	55.	30.030	—5.	+5.	05.	18.	—6.	06.	24.
15	49.	30.136	58.	30.168	17.	17.	17.	20.	12.	16.	8.
16	52.	30.166	58.	30.084	08.	15.	11.5	30.	04.	17.	26.
17	53.	29.958	61.	29.523	15.	28.	21.5	26.	09.	17.5	17.
18	52.	29.554	48.	29.594	28.	54.	41.	34.	21.	27.5	13.
19	50.	29.694	60.	29.726	16.	18.	17.	40.	13.	26.5	27.
20	52.	29.874	58.	29.610	29.	27.	28.	29.	20.	24.5	9.
21	55.	29.616	62.	29.650	50.	53.	51.5	30.	16.	23.	14.
22	60.	29.800	60.	29.662	53.	35.	44.	36.	19.	27.5	17.
23	60.	29.372	63.	29.660	36.	35.	35.5	42.	33.	37.5	9.
24	57.	29.762	65.	29.758	27.	34.	30.5	45.	25.	35.	20.
25	53.	29.858	50.	29.926	22.	25.	23.5	39.	21.	30.	18.
26	47.	29.928	54.	29.700	18.	21.	19.5	35.	14.	24.5	21.
27	47.	29.384	59.	29.300	11.	31.	21.	27.	06.	16.5	21.
28	54.	29.268	51.	29.612	22.	04.	13.	35.	03.	19.	32.
29	51.	29.758	61.	29.690	11.	19.	15.	23.	0.	11.5	23.
30	60.	29.672	67.	29.668	22.	47.	34.5	22.	11.	16.5	11.
31	67.	29.828	59.	30.500	42.	25.	33.5	43.	11.	27.	32.
Sum					763.	836.	794.5	1031.	527.	776.	389.
Mean					24.6	26.96	25.6	33.2	17.	25.	16.4

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

December, 1898.	Precipitation. Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.	Prevailing wind direction.	Character of day.	Remarks.
1	.....	.....	.....	.....	W.	Partly cloudy..	Maximum temperature, 45; date, 24th.
2	.....	.....	.....	.....	N.W.	Partly cloudy..	
3	.....	.....	.....	.....	N.	Partly cloudy..	Minimum temperature, —6; date, 14th.
4	5.30 a. m.	Night.	1.75	.....	E.	Partly cloudy..	
5	.....	.....	.....	.....	W.	Partly cloudy..	
6	.....	.....	.....	.....	W.	Partly cloudy..	Mean temperature (mean max. + mean min. ÷ 2), 25.1.
7	.....	.....	.....	.....	W.	Partly cloudy..	
8	.....	.....	.....	.....	S. W.	Partly cloudy..	
9	.....	.....	.....	.....	W.	Partly cloudy..	
10	.....	.....	.....	.....	W.	Partly cloudy..	Mean temperature (8 + 8 ÷ 2), 25.8.
11	.....	.....	.....	.....	S. W.	Partly cloudy..	
12	10.30 a. m.	Night.	.31	5.	N.W.	Cloudy	Mean max. temperature, 33.2; mean min. temperature, 17.
13	.....	.....	.....	.....	W.	Clear	
14	.....	.....	.....	.....	S. W.	Clear	
15	.....	.....	.....	.....	S.	Partly cloudy..	
16	.....	.....	.....	.....	S.	Partly cloudy..	Total precipitation, 2.43 inches.
17	.....	.....	.....	.....	W.	Partly cloudy..	
18	.....	.....	.....	.....	W.	Clear	Greatest precipitation in any 24 consecutive hours, 1.75; date, Dec. 4.
19	During night.		.....	1.	N.	Clear	
20	.....	During night.	.04	.....	N.	Cloudy.....	
21	5 p. m.	9 p. m.	.....	.....	N.	Cloudy.....	Total snowfall during the month, 6½ inches.
22	During night.	6 a. m.	.37	.....	S. E.	Partly cloudy..	
23	.....	.....	.....	.....	W.	Clear	No. of clear days, 6; partly cloudy, 21; cloudy, 4; on which .01 or more precipitation fell, 8.
24	.....	.....	.....	.....	S. W.	Partly cloudy..	
25	.....	.....	.....	.....	W.	Partly cloudy..	
26	.....	.....	.....	.....	N.	Partly cloudy..	
27	.....	.....	.....	.....	S.	Partly cloudy..	
28	.....	.....	.....	.....	W.	Clear	Prevailing wind direction, W.
29	8 a. m.	11 a. m.	*	.05	S. W.	Partly cloudy..	
30	.....	.....	.....	.....	S. W.	Partly cloudy..	Very high wind on the 28th. Therm. falling to zero that night.
31	8 a. m.	.....	.....	.....	W.	Cloudy.....	
							Quite heavy snowstorm beginning in rain on 31st, ending in snow on Jan. 1, 1899.
Sum..	.....	.....	2.43	6.5			
.....	.....	.....	.....	.....			

* Trace.

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° 8′ N.

January, 1899.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	54.	30.050	50.	30.176	15.	—4.	5.5	22.	—5.	9.5	28.
2	52.	30.460	64.	30.562	—7.	12.	2.5	17.	—8.	12.5	5.
3	59.	30.200	64.	31.400	17.	25.	21.	28.	17.	22.5	11.
4	62.	29.942	65.	29.818	23.	40.	31.5	43.	15.	22.5	33.
5	68.	29.522	70.	29.986	50.	40.	45.	54.	36.	47.	14.
6	70.	30.064	55.	29.494	29.	20.	24.5	36.	20.	25.	10.
7	65.	29.450	66.	29.564	28.	20.	24.	30.	18.	24.	12.
8	58.	30.049	60.	29.882	25.	23.	24.	33.	15.	24.	18.
9	54.	29.836	60.	29.924	29.	20.	24.5	35.	16.	37.	38.
10	55.	30.100	55.	30.140	1.	—2.	—5.	17.	—5.	6.	22.
11	61.	30.140	60.	30.202	—1.	10.	4.5	15.	—7.	4.	22.
12	55.	30.020	63.	30.206	2.	16.	9.	29.	1.	15.	28.
13	58.	30.184	64.	30.020	8.	29.	18.5	30.	3.	16.5	27.
14	62.	29.784	65.	29.184	32.	33.	32.5	31.	23.	32.	15.
15	53.	29.310	50.	29.732	37.	38.	37.5	42.	27.	34.5	15.
16	59.	29.870	65.	29.732	28.	37.	32.5	38.	26.	32.	12.
17	65.	29.380	69.	29.596	35.	39.	37.	47.	34.	40.5	13.
18	65.	29.764	59.	29.924	22.	15.	18.5	34.	11.	19.	23.
19	60.	30.002	67.	29.992	8.	25.	16.5	34.	6.	20.	28.
20	63.	29.936	65.	29.876	13.	31.	22.	45.	11.	28.	34.
21	63.	29.760	66.	29.460	25.	34.	29.5	43.	24.	33.5	19.
22	61.	29.382	55.	29.500	32.	34.	33.	41.	30.	35.5	11.
23	63.	29.742	72.	29.870	32.	33.	32.5	41.	29.	35.	12.
24	65.	29.672	73.	29.220	32.	35.	33.5	36.	28.	32.	8.
25	65.	29.192	63.	29.690	30.	21.	25.5	31.	16.	26.	15.
26	62.	29.700	70.	29.340	11.	39.	25.	41.	8.	24.5	33.
27	65.	29.292	60.	29.704	24.	7.	15.5	37.	4.	15.	13.
28	55.	29.900	60.	29.576	0.	16.	8.	24.	—2.	11.	26.
29	48.	29.490	44.	29.732	12.	12.	12.	24.	7.	15.5	17.
30	50.	29.768	58.	29.768	4.	12.	8.	23.	2.	20.	6.
31	55.	29.844	55.	29.718	15.	15.	15.	18.	8.	13.	10.
Sum ...	.....	.....	.....	.....	611.	725.	668.	1019.	498.	742.5	564.
Mean.	.....	.....	.....	.....	19.6	23.4	21.5	33+	13.	24.	18–

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

January, 1899.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.			
1	.....	9 a. m.	2.1	10.	N.	Partly cloudy.	Maximum temperature, 54; date, 5th.
2	.....	.....	.....	.....	N.	Clear.	
3	.....	.....	.....	.....	S.W.	Clear.	Minimum temperature,—7; date, 2d.
4	.....	.....	.....	.....	S.W.	Partly cloudy.	
5	.....	.....	.....	.....	W.	Cloudy.	Mean temperature (mean max.+mean min.÷2), 23.
6	8 a. m.	Night.	1.7	6.	N.	Cloudy.	
7	.....	.....	.....	.....	W.	Clear.	
8	.....	.....	.....	.....	W.	Clear.	Mean temperature (8+8÷2), 21.5.
9	.....	.....	.....	.....	N.W.	Cloudy.	
10	.....	.....	.....	.....	N.W.	Clear.	Mean max. temperature, 33; mean min. temperature, 13.
11	.....	.....	.....	.....	N.W.	Clear.	
12	.....	.....	.....	.....	N.W.	Clear.	
13	6 p. m.	.....	.....	*	N.W.	Partly cloudy.	Total precipitation, 6.7 inches.
14	.....	.....	.....	.....	N.E.	Cloudy.	
15	.....	6 a. m.	1.3	.....	W.	Partly cloudy.	Greatest precipitation in any 24 consecutive hours, 1.7; date, 6th.
16	8 p. m.	Night.	.7	.....	S.E.	Partly cloudy.	
17	.....	.....	.....	.....	W.	Partly cloudy.	
18	.....	.....	.....	.....	N.W.	Partly cloudy.	
19	.....	.....	.....	.....	W.	Partly cloudy.	Total snowfall during month, 17 inches.
20	.....	.....	.....	.....	S.W.	Partly cloudy.	
21	.....	.....	.....	.....	S.W.	Partly cloudy.	Number of clear days, 7; partly cloudy, 18; cloudy, 6; on which .01 or more precipitation fell, 6.
22	.....	.....	.....	.....	W.	Partly cloudy.	
23	.....	.....	.....	.....	W.	Partly cloudy.	
24	12 m.	.....	.....	.....	N.W.	Partly cloudy.	
25	.....	7 a. m.	.9	1.	N.W.	Partly cloudy.	Prevailing wind, W. N. W.
26	.....	.....	.....	.....	N.W.	Cloudy.	
27	.....	.....	.....	.....	N.W.	Partly cloudy.	
28	.....	.....	.....	.....	S.	Cloudy.	
29	.....	.....	.....	.....	W.	Partly cloudy.	
30	.....	.....	.....	.....	W.	Partly cloudy.	
31	.....	.....	.....	.....	N.E.	Partly cloudy.	
Sum	.....	.....	7.7	17.			

* Trace.

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° 8′ N.

February, 1889.	8 A. M.		8 P. M.			TEMPERATURE.					
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	59.	29.388	57.	29.926	9.	8.	8.5	15.	7.	11.	8
2	55.	29.928	62.	29.904	8.	16.	12.	25.	5.	15.	20
3	65.	29.944	60.	29.682	13.	22.	17.5	23.	9.	17.	14
4	58.	29.478	58.	29.736	25.	21.	23.	33.	18	24.5	15
5	50.	29.744	45.	29.770	12.	18.	15.	23.	7.	15	16
6	55.	29.820	64.	29.750	20.	25.	22.5	30.	16.	23	14
7	55.	29.700	64.	29.708	14.	19.	26.5	30.	12.	16.	18
8	49.	29.392	58.	29.100	11.	12.	11.5	14.	8.	12.	6
9	58.	29.338	62.	29.458	4.	1.	2.5	10.	0.	5.	10
10	55.	29.624	56.	29.802	—1.	1.	0.	6.	—2.	2	8
11	54.	30.038	56.	30.144	—4.	2.	—2.	5.	—7.	1.	12
12	51.	30.114	55.	30.008	4.	6.	5.	8.	0.	4	8
13	47.	29.742	46.	28.818	6.	10.	8.	16.	4.	10.	12
14	54.	29.192	59.	29.824	13.	17.	15.	21	10.	15.5	11
15	58.	30.184	66.	30.062	2.	26.	14.	32.	3.	17.5	29
16	63.	30.002	70.	29.832	14.	32.	24.	43.	10.	26.5	33
17	68.	29.604	74.	29.604	34.	43.	38.5	48.	30.	39.	18
18	71.	29.644	72.	29.478	38.	36.	37.	51.	28.	39.5	23
19	62.	29.260	55.	29.524	37.	34.	35.5	43.	31.	37.	12
20	60.	29.362	73.	29.374	32.	42.	37.	49.	27.	38.	22
21	70.	29.480	72.	29.516	37.	42.	39.5	52.	32.	42.	20
22	69.	29.352	65.	29.208	35.	41.	38.	46.	34.	40.	12
23	66.	29.272	72.	29.444	36.	34.	35.	41.	33.	37.	8
24	69.	29.614	64.	29.890	23.	25.	24.	30.	20.	25.	10
25	58.	30.074	50.	30.116	20.	25.	22.5	31.	16.	23.5	15
26	56.	30.156	48.	29.980	16.	29.	22.5	32.	10.	21.	22
27	58.	29.552	69.	29.524	37.	37.	37.	42.	29.	35.5	13
28	58.	29.766	68.	29.633	27.	31.	29.	41.	15.	28.	26
Sum					522.	655.	598.5	830.	415.	625.5	455
Mean					18.6+	23.4—	21.4—	29.6+	14.8+	22.3+	15.5

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

February, 1899.	PRECIPITATION. Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.	Prevailing wind direction.	Character of day.	Remarks.
1					N. W.	Partly cloudy..	Maximum temperature, 52; date, 21st.
2					N. W.	Partly cloudy..	
3	12 m.				N. E.	Cloudy	Minimum temperature, —7; date, 11th.
4		9 a. m.	.4	3.0	N.	Partly cloudy..	
5					N.	Cloudy	Mean temperature (mean max. + mean min.÷2), 22.2
6					N. W.	Partly cloudy..	
7	6 a. m.	9 a. m.		.5	N. E.	Partly cloudy..	Mean temperature (8+8÷2), 21.
8	5 a. m.	10 p. m.	.5	6.0	N.	Cloudy	
9					W.	Partly cloudy..	
10					W.	Clear	Mean max. temperature, 29.6+; mean min. temperature, 14.8+.
11					N. W.	Partly cloudy..	
12	1.15 a. m.				N.	Cloudy	
13					N. E.	Cloudy	Total precipitation, 2.01 inches.
14		5 a. m.	.9	12.	N. W.	Partly cloudy..	
15					S. W.	Partly cloudy..	
16					S. E.	Partly cloudy..	Greatest precipitation in any 24 consecutive hours, .9 (nearly); date, 13th.
17					W.	Clear	
18	During night.		.01		N. W.	Clear	
19					W.	Clear	Total snowfall during the month, 21.5 inches.
20					W.	Clear	
21		*			S. W.	Partly cloudy..	No. of clear days, 7; partly cloudy, 14; cloudy, 7; on which .01 or more precipitation fell, 9.
22					S. W.	Clear	
23					N. W.	Clear	
24					N. W.	Partly cloudy..	
25					N. W.	Partly cloudy..	Prevailing wind direction, N. W.
26	5 p. m.			*	S.	Cloudy	
27		10.30 a. m.	.2		N. W.	Cloudy	Heavy snowstorm and very high winds on 13th and 14th; began to snow on 12th; partly cleared toward night, but increased during night and on 13th; clearing early on morning of 14th. Bar. low on 13th and 14th; snow drifted badly, stopping travel on railroad for nearly the 24 hours of 14th.
28					W.	Partly cloudy..	
Sum			2.01	21.5			

* Trace.

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° 8′ N.

March, 1880.	8 A. M.		8 P. M.		TEMPERATURE.						
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	Maximum.	Minimum.	Mean.	Range.
1	76.	29.572	70.	29.760	32.	33.	32.5	43.	30.	36.5	13.
2	66.	29.884	68.	29.868	25.	26.	25.5	30.	20.	25.	10.
3	55.	29.879	73.	29.938	29.	34.	31.5	37.	25.	31.	12.
4	65.	29.880	67.	29.834	33.	33.	33.	36.	32.	34.	4.
5	53.	29.486	51.	29.012	35.	40.	37.5	49.	32.	40.5	17.
6	61.	29.562	69.	29.802	33.	34.	33.5	47.	30.	38.5	17.
7	49.	29.442	59.	29.112	31.	27.	29.	31.	25.	28.	6.
8	60.	29.532	56.	29.844	20.	28.	24.	32.	14.	23.	18.
9	63.	29.962	66.	29.846	17.	26.	21.5	29.	09.	19.	20.
10	65.	30.032	60.	30.124	19.	27.	23.	34.	13.	23.5	21.
11	64.	30.068	66.	29.846	28.	39.	33.5	39.	24.	31.5	15.
12	61.	29.592	60.	29.366	43.	47.	45.	58.	39.	48.5	19.
13	65.	29.672	65.	29.988	39.	31.	35.	42.	27.	34.5	15.
14	60.	30.192	67.	30.244	22.	26.	24.	30.	21.	25.5	9.
15	68.	30.200	57.	29.578	29.	32.	30.5	32.	25.	28.5	7.
16	66.	29.388	59.	29.736	35.	24.	29.5	41.	18.	29.5	23.
17	60.	29.916	56.	29.928	12.	15.	13.5	22.	10.	16.	12.
18	58.	29.914	67.	29.492	15.	32.	23.5	33.	12.	22.5	21.
19	43.	29.174	48.	28.699	28.	31.	29.5	31.	20.	25.5	11.
20	60.	29.544	56.	29.572	27.	24.	25.5	30.	22.	26.	8.
21	60.	29.998	60.	30.082	15.	21.	18.	28.	13.	20.5	15.
22	61.	29.862	53.	29.842	22.	26.	24.	31.	19.	25.	12.
23	52.	29.660	55.	29.468	26.	28.	27.	33.	24.	28.5	9.
24	60.	29.568	63.	29.610	28.	27.	27.5	36.	26.	30.5	9.
25	65.	29.634	62.	29.544	23.	25.	24.	31.	14.	22.5	17.
26	47.	29.434	45.	29.592	17.	33.	25.	37.	10.	23.5	27.
27	55.	29.836	64.	29.040	34.	33.	33.5	43.	28.	35.5	15.
28	63.	29.890	64.	29.630	33.	34.	33.5	43.	23.	33.	20.
29	64.	28.764	62.	29.155	41.	30.	35.5	42.	26.	34.	16.
30	66.	29.400	65.	29.562	29.	31.	30.	35.	26.	30.5	9.
31	65.	29.472	71.	29.444	27.	33.	30.	45.	26.	35.5	19.
Sum					847.	930.	888.5	1129.	683.	906.	446.
Mean					27.3	30.	28.6+	36.+	22.	29.+	14.+

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

March, 1899.	PRECIPITATION. Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.	Prevailing wind direction.	Character of day.	Remarks.
1	.....	.....	.....	.....	W.	Clear	Maximum temperature, 58; date, 12th.
2	11.30 a. m.	.....	.....	4.	N. E.	Cloudy.....	
3	.....	8 a. m.	.25	.....	E.	Cloudy.....	Minimum temperature, 9: date, 9th.
4	6.30 a. m.	.....	.....	.....	N. E.	Cloudy.....	
5	.....	12.15 p. m.	.70	.....	S. W.	Cloudy.....	Mean temperature (mean max.+ mean min. ÷ 2), 29.
6	.....	.....	.....	.....	N.W.	Clear	
7	7 a. m.	Night.	.35	4.	N. E.	Cloudy.....	Mean temperature (8 + 8 ÷ 2), 28.6.
8	.....	.....	.....	.....	N.W.	Clear	
9	.....	.....	.....	*	S. E.	Cloudy.....	Mean max. temperature, 36 +; mean min. temperature, 22.
10	.....	.....	.....	.....	S. E.	Clear	
11	.....	.....	.....	*	S. W.	Cloudy.....	
12	3 p. m.	Night.	.10	.....	S. W.	Cloudy.....	Total precipitation, 4.76 inches.
13	.....	.....	.....	.....	N. E.	Clear	
14	.....	.....	.....	*	E.	Cloudy.....	Greatest precipitation in any 24 consecutive hours, 1.5 inches; date, 19th.
15	4 p. m.	Night.	.43	2.	S. E.	Cloudy.....	
16	.....	.....	.....	.....	N.W.	Clear	
17	.....	.....	.....	.....	N.W.	Clear	
18	7 a. m.	.....	.....	4.	S. E.	Cloudy.....	
19	.....	Night.	1.50	.....	N.W.	Partly cloudy..	
20	.....	.....	.....	.....	W.	Partly cloudy..	Total snowfall during the month, 21.5 inches.
21	.....	.....	.....	.....	N.W.	Clear	
22	5.30 a. m.	Night.	.25	4.	N. E.	Cloudy.....	
23	9 a. m.	.....	.....	3.	N.	Cloudy.....	No. of clear days, 11; partly cloudy, 5; cloudy, 15; on which .01 or more precipitation fell, 13.
24	.....	7 a. m.	.58	.....	N.W.	Clear	
25	.....	.....	.....	.....	N.W.	Clear	
26	7 a. m.	12 m.	.....	.5	N.W.	Partly cloudy..	Prevailing wind direction, N. W.
27	.....	.....	.....	.....	S. E.	Partly cloudy..	
28	7 p. m.	.....	.....	.....	S. E.	Cloudy.....	
29	.....	8 a. m.	.60	.....	W.	Partly cloudy..	Lightning was seen several times on eve of 6th, and during heavy rain on eve of 12th very bright flashes were seen in S. and S.W. and faint thunder was heard.
30	.....	.....	.....	.....	S. W.	Partly cloudy..	
31	.....	.....	.....	.....	S.	Clear	
Sum...	.....	.....	4.76	21.5+			

* Trace.

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° N.

April, 1880.	8 A. M.		8 P. M.		TEMPERATURE.								
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Mean.	Range.
1	72.	29.508	65.	29.498	33.	32.	32.5	32.	32.	39.	25.	32	
2	56.	29.544	55.	29.509	30.	31.	30.5	25.	29.	36.	24.	30	
3	67.	29.670	65.	29.714	33.	36.	34.5	30.	32.	42.	25.	33.5	
4	68.	29.814	67.	29.802	35.	35.	35.	31.	32.	44.	28.	36.	
5	65.	29.926	68.	29.974	34.	34.	34.	33.	29.	43.	26.	34.5	
6	69.	30.088	66.	29.998	37.	35.	36.	31.	33.	51.	28.	39.5	
7	66.	29.942	67.	29.838	34.	42.	38.	33.	40.	52	25.	39.	
8	60.	29.374	65.	29.310	40.	42.	41.	40.	41.	48.	32.	40	
9	65.	29.292	57.	29.534	42.	36.	39.	39.	34.	47.	33.	40	
10	67.	29.724	67.	29.820	38.	38.	38.	33.	34.	47.	29.	38	
11	64.	30.030	66.	29.982	37.	37.	37.	33.	36.	47.	25.	36.	
12	67.	29.832	62.	29.526	39.	34.	36.5	36.	33.	45.	24.	34.5	
13	60.	29.508	63.	29.684	45.	45.	45.	40.	40.	51.	39.	45.5	
14	65.	29.658	65.	29.544	39.	47.	43.	39.	44.	52.	30.	41.	
15	72.	29.662	74.	29.636	52.	46.	49.	47.	40.	59.	32.	45.5	
16	60.	29.628	53.	29.472	40.	36.	38.	38.	36.	46.	29.	37.5	
17	64.	29.556	66.	29.684	44.	40.	42.	43.	37.	52.	30.	41.	
18	71.	29.844	67.	29.840	51.	57.	54.	41.	45.	65.	37.	51.	
19	70.	29.964	65.	29.982	47.	40.	43.5	41.	38.	51.	37.	44.	
20	70.	30.118	69.	29.962	45.	43.	44.	42.	38.	48.	33.	40.5	
21	64.	29.936	60.	29.982	42.	41.	41.5	40.	36.	53.	29.	41.5	
22	69.	29.974	64.	29.928	52.	48.	50.	44.	44.	66.	35.	50.5	
23	65.	29.864	67.	29.998	62.	59.	60.5	50.	48.	71.	34.	52.5	
24	75.	29.968	62.	29.832	52.	49.	50.5	45.	45.	59.	35.	47.	
25	72.	29.764	68.	29.744	56.	56.	56.	52.	54.	74.	41.	57.5	
26	75.	29.782	65.	29.772	57.	48.	57.5	53.	46.	62.	40.	51.	
27	70.	29.920	65.	29.964	51.	46.	48.5	48.	41.	56.	40.	48.	
28	71.	29.934	67.	29.882	53.	55.	54.	44.	50.	72.	53.	62.5	
29	71.	29.938	75.	29.808	58.	66.	62.	53.	59.	84.	37.	60.5	
30	74.	29.878	78.	29.776	63.	71.	67.	56.	63.	86.	51.	68.5	
Sum					1341.	1325.	1341.			1648.	989.	1318.5	659.
Mean					44.+	44+	44+			54.9+	32.9+	44.+	21.+

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

April, 1899.	Precipitation.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.			
1					N.W.	Clear.	Maximum temperature, 86; date, 30th.
2					N.W.	Clear.	
3					N.W.	Clear.	Minimum temperature, 24; date, 2d and 12th.
4					N.W.	Clear.	
5					N.E.	Clear.	
6					S.	Clear.	Mean temperature (mean max.+mean min.÷2), 43.9.
7	9 p. m.			*	S.W.	Partly cloudy.	
8		12 m.	.65		N.E.	Cloudy.	Mean temperature (8+8÷2), 44.4.
9					N.W.	Partly cloudy.	
10					N.W.	Clear.	
11					S.	Clear.	Mean max. temperature, 54.9; mean min. temperature, 32.9.
12	9 a. m.	Night.	.24		W.	Cloudy.	
13					N.W.	Clear.	
14	Night.	8.30 a. m.	.08		S.	Partly cloudy.	Total precipitation, 1.38 inches.
15					N.	Partly cloudy.	
16	3 p. m.	Night.	.23		N.	Cloudy.	Greatest precipitation in any 24 consecutive hours, .65; date, 8th.
17					N.W.	Clear.	
18					N.	Clear.	
19					S.E.	Clear.	
20			*		S.E.	Cloudy.	
21					S.E.	Cloudy.	Number of clear days, 17; partly cloudy, 8; cloudy, 5; on which .01 or more precipitation fell, 6.
22					S.	Clear.	
23					N.	Clear.	
24					S.	Partly cloudy.	
25	7.30 p. m.	Night.	.18		W.	Partly cloudy.	
26					S.E.	Partly cloudy.	
27					S.	Clear.	Prevailing wind, N. W. and S.
28					S.	Clear.	
29					S.	Clear.	
30					S.W.	Partly cloudy.	
Sum ...			1.38				

* Trace.

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° [illegible]

May, 1888.	8 A. M.		8 P. M.		TEMPERATURE.							
	Attached thermometer.	Barometer.	Attached thermometer.	Barometer.	8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Mean.
1	76.	29.732	76.	29.784	70.	61.	65.5	63.	59.	87.	58.	72.5
2	72.	29.702	67.	29.612	55.	46.	50.5	54.	46.	56.	45.	50.5
3	58.	29.768	64.	29.910	47.	42.	46.5	43.	39.	56.	35.	45.5
4	67.	29.826	65.	29.810	49.	52.	50.5	44.	48.	66.	36.	51.
5	74.	29.982	63.	29.942	50.	48.	49.0	46.	46.	57.	40.	48.5
6	68.	29.968	69.	29.832	55.	60.	57.5	48.	56.	76.	34.	55
7	72.	29.758	72.	29.724	68.	65.	66.5	59.	61.	79.	45.	62.1
8	63.	29.712	60.	29.696	57.	47.	52.0	49.	46.	63.	47.	55
9	65.	29.492	63.	29.604	59.	59.	51.0	55.	49.	74.	45.	59.5
10	68.	29.762	67.	29.798	58.	53.	55.5	49.	49.	73.	43.	58
11	68.	29.678	66.	29.498	61.	51.	56.0	58.	50.	73.	38.	55.5
12	68.	29.518	75.	29.618	59.	62.	60.5	50.	50.	71.	48.	59.
13	72.	29.732	64.	29.776	63.	54.	58.5	53.	54.	69.	41.	55.
14	63.	29.730	61.	29.718	53.	54.	53.5	42.	49.	65.	46.	55.5
15	60.	29.814	58.	29.776	56.	50.	53.	41.	42.	59.	39.	49
16	67.	29.768	62.	29.662	52.	52.	52.	45.	46.	60.	38.	49.
17	73.	29.732	62.	29.812	53.	48.	50.5	47.	45.	63.	42.	52.5
18	60.	29.862	55.	29.800	49.	46.	47.5	46.	45.	50.	39.	44.5
19	57.	29.706	63.	29.662	46.	48.	47.	46.	46.	50.	44.	47.
20	59.	29.542	65.	29.562	47.	49.	48.	45.	46.	52.	44.	48.
21	55.	29.542	57.	29.718	47.	48.	47.5	45.	47.	52.	45.	48.5
22	67.	29.832	60.	29.896	50.	46.	48.	44.	44.	58.	43.	50.5
23	61.	29.924	62.	29.920	53.	51.	52.	41.	49.	63.	41.	52.
24	65.	29.982	64.	29.937	59.	55.	57.	54.	52.	72.	35.	53.5
25	68.	29.924	71.	29.850	64.	67.	65.5	56.	59.	75.	40.	57.5
26	71.	29.864	79.	29.770	65.	68.	66.5	61.	59.	80.	49.	64.5
27	70.	29.694	75.	29.606	65.	69.	67.	56.	59.	83.	52.	67.5
28	60.	29.600	64.	29.850	55.	52.	53.5	53.	51.	51.	49.	53.
29	61.	29.902	59.	29.808	54.	50	52.	50.	50.	56.	47.	51.5
30	61.	29.638	73.	29.584	54.	73.	63.5	53.	59.	81.	48.	64.5
31	74.	29.674	80.	29.626	70.	72.	71.	60.	65.	85.	65.	75
Sum...	.....	.....	.....	.....	1743.	1698.	1722.5	1566.	1566.	2061.	1353.	1707
Mean..	.....	.....	.....	.....	56.2	54.8	55.5	50.2	50.5	66.5	43.6	55.0

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

May, 1899.	PRECIPITATION.				Prevailing wind direction.	Character of day.	Remarks.
	Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.			
1	7 p. m.	Night.	.46	.....	N. E.	Partly cloudy..	Maximum temperature, 87; date, 1st.
2	.....	.....	.....	.....	S. E.	Cloudy.....	
3	.....	.....	.....	.....	S. E.	Partly cloudy..	Minimum temperature, 28; date, 4th.
4	.....	.....	.....	.....	N. E.	Clear.....	
5	.....	.....	.....	.....	S.	Clear.....	Mean temperature (mean max. + mean min. ÷ 2), 55.
6	.....	.....	.....	.....	S. W.	Partly cloudy..	
7	.....	.....	.....	.....	E.	Clear.....	
8	.....	.....	.....	.....	E.	Partly cloudy..	Mean temperature (8 + 8 ÷ 2), 55.5.
9	.....	.....	.....	.....	N.	Partly cloudy..	
10	5 p. m.	Night.	.12	.....	S. W.	Clear.....	Mean max. temperature, 66.5; mean min. temperature, 43.6.
11	.....	.....	.....	.....	W.	Partly cloudy..	
12	.....	.....	.....	.....	N. W.	Partly cloudy..	
13	6.30 p. m.	Night.	.13	.....	S.	Cloudy.....	
14	.....	.....	.....	.....	N. W.	Partly cloudy..	Total precipitation, 1.08 inches.
15	.....	.....	.....	.....	N. W.	Clear.....	
16	.....	.....	.....	.....	E.	Clear.....	Greatest precipitation in any 24 consecutive hours, .46; date, 1st.
17	.....	.....	.....	.....	S. E.	Clear.....	
18	7 p. m.	.....	.....	.....	S. E.	Cloudy.....	
19	.....	.....	.11	.....	S. E.	Cloudy.....	
20	.....	.....	.04	.....	N. E.	Cloudy.....	No. of clear days, 9; partly cloudy, 14; cloudy, 8; on which .01 or more precipitation fell, 8.
21	.....	Night.	.11	.....	N. E.	Cloudy.....	
22	.....	.....	.....	.....	S.	Partly cloudy..	
23	.....	.....	.....	.....	S. E.	Partly cloudy..	
24	.....	.....	.....	.....	S.	Clear.....	
25	.....	.....	.....	.....	S. W.	Partly cloudy..	Prevailing wind direction, S. E.
26	.....	.....	.....	.....	W.	Partly cloudy..	
27	Night.	Night.	.05	.....	S. W.	Partly cloudy..	
28	.....	.....	.....	.....	E.	Cloudy.....	
29	4 p. m.	Night.	.06	.....	S. E.	Cloudy.....	
30	.....	.....	.....	.....	N. W.	Partly cloudy..	
31	.....	.....	.....	.....	N. W.	Clear.....	
Sum...	.....	.....	1.08	.....			
.....	.....	.....	.....	.....			

Digitized by Google

METEOROLOGICAL

DURHAM, STRAFFORD COUNTY, NEW HAMPSHIRE. LAT. 43° [illegible]

June, 1869.	8 A. M. Attached thermometer.	8 A. M. Barometer.	8 P. M. Attached thermometer.	8 P. M. Barometer.	Temperature. 8 a. m.	8 p. m.	Mean.	8 a. m., wet.	8 p. m., wet.	Maximum.	Minimum.	Mean.	Rainfall.
1	79.	29.624	81.	29.676	72.	75.	73.5	65.	70	89.	53.	71	[illegible]
2	85.	29.542	83.	29.622	71.	73.	72.	68.	69	86.	66.	76	[illegible]
3	80.	29.798	78.	29.718	71.	69.	70.	60.	61	81.	59.	70	[illegible]
4	78.	29.872	71.	29.716	68.	61.	64.5	59.	58	76.	50.	63	[illegible]
5	77.	29.724	80.	29.702	75.	73.	74.	70.	68	92.	55.	73.5	[illegible]
6	82.	29.614	82.	29.614	81.	80.	80.5	73.	76	90.	73.	81.5	[illegible]
7	74.	29.722	68.	29.786	58.	54.	56.	56.	52	63.	50.	56.5	[illegible]
8	66.	29.538	81.	29.500	58.	78.	68.	57.	63	89.	51.	70	[illegible]
9	73.	29.662	75.	29.618	66.	68.	67.	57.	62	77.	62.	69.5	[illegible]
10	70.	29.762	73.	29.772	64.	69.	66.5	50.	54	73.	52.	62.5	[illegible]
11	72.	29.902	73.	29.932	67.	61.	64.	52.	55	76.	45.	60.5	[illegible]
12	73.	29.906	76.	29.826	67.	69.	68.	59.	63	78.	46.	62.	[illegible]
13	78.	29.824	84.	29.730	78.	76.	77.	67.	69	88.	70.	79.	[illegible]
14	83.	29.690	83.	29.650	78.	74.	76.	72.	70	93.	64.	78.5	[illegible]
15	72.	29.666	68.	29.590	63.	57.	60.	60.	56	69.	56.	62.5	[illegible]
16	72.	29.508	71.	29.732	67.	62.	64.5	65.	55	72.	55.	63.5	[illegible]
17	70.	29.840	73.	29.878	64.	64.	64.	56.	59	74.	52.	63	[illegible]
18	70.	29.858	74.	29.760	63.	62.	62.5	60.	58	76.	49.	62.5	[illegible]
19	74.	29.686	73.	29.666	68.	62.	65.	60.	60	82.	47.	64.5	[illegible]
20	73.	29.642	73.	29.442	67.	65.	66.	63.	63	82.	47.	64.5	[illegible]
21	71.	29.478	72.	29.634	66.	64.	65.	56.	56	73.	57.	65	[illegible]
22	68.	29.860	73.	29.964	63.	66.	64.5	50.	58	71.	49.	60	[illegible]
23	70.	30.000	72.	29.878	64.	66.	65.	58.	58	70.	50.	60	[illegible]
24	79.	29.840	81.	29.768	75.	74.	74.5	67.	60	90.	57.	63.5	[illegible]
25	78.	29.880	75.	29.770	70.	65.	72.5	66.	64	72.	59.	65.5	[illegible]
26	73.	29.776	76.	29.824	71.	67.	69.	60.	55	80.	54.	67	[illegible]
27	73.	29.840	76.	29.790	67.	69.	68.	57.	58	79.	45.	62	[illegible]
28	69.	29.728	66.	29.646	64.	57.	65.5	59.	57	67.	54.	60.5	[illegible]
29	63.	29.624	72.	29.638	60.	68.	64.	56.	53	75.	57.	66	[illegible]
30	65.	29.734	72.	29.874	60.	66.	63.	48.	55	75.	48.	61.5	[illegible]
Sum....	....	....	....	....	2026.	1914.	2030.	....	....	2368.	1621.	1979.5	[illegible]
Mean....	....	....	....	....	67.53	63.8	67.6+	....	....	78.9+	54.033	65.98	[illegible]

Digitized by Google

RECORD

LONG. 70° 56′ W. BAROMETER 125 FEET ABOVE SEA LEVEL

June, 1899.	Precipitation. Time of beginning.	Time of ending.	Total amount in inches.	Snowfall in inches.	Prevailing wind direction.	Character of day.	Remarks.
1	.....	.....	.....	.....	S.W.	Clear.	Maximum temperature, 93; date, 14th.
2	.....	.....	.....	.....	S.E.	Clear.	
3	.....	.....	.....	.....	N.W.	Clear.	Minimum temperature, 45; date, 11th and 27th.
4	.....	.....	.....	.....	S.	Cloudy.	
5	5.30 p. m.	6.10 p. m.	.03	.....	W.	Partly cloudy.	
6	.....	.....	.....	.....	E.	Clear.	Mean temperature (mean max.+mean min.÷2), 66.46+
7	8 p. m.	Night.	.01	.....	S.E.	Partly cloudy.	
8	.....	.....	.....	.....	W.	Partly cloudy.	
9	.....	.....	.....	.....	W.	Cloudy.	Mean temperature (8+8÷2), 65.6.
10	.....	.....	.....	.....	N.	Partly cloudy.	
11	.....	.....	.....	.....	S.	Clear.	Mean max. temperature, 78.9+; mean min. temperature, 54.03+
12	.....	.....	.....	.....	S.W.	Partly cloudy.	
13	.....	.....	.....	.....	S.W.	Partly cloudy.	
14	3 p. m.	5 p. m.	.08	.....	N.W.	Partly cloudy.	
15	3.45 p. m.	Night.	.28	.....	S.E.	Cloudy.	Total precipitation, 1.14 inches.
16	.....	.....	.....	.....	N.	Partly cloudy.	
17	.....	.....	.....	.....	S.	Partly cloudy.	Greatest precipitation in any 24 consecutive hours, .38 inches; date, 28th.
18	.....	.....	.....	.....	S.	Partly cloudy.	
19	1.15 p. m.	3.45 p. m.	.15	.....	E.	Partly cloudy.	
20	4.35 p. m.	Night.	.15	.....	S.	Partly cloudy.	
21	.....	.....	.....	.....	N.W.	Partly cloudy.	Number of clear days, 7; partly cloudy, 18; cloudy, 5; on which .01 or more precipitation fell, 9.
22	.....	.....	.....	.....	N.W.	Partly cloudy.	
23	.....	.....	.....	.....	S.W.	Partly cloudy.	
24	Night.	Night.	.03	.....	W.	Partly cloudy.	
25	9 a. m.	3 p. m.	.03	.....	S.W.	Cloudy.	
26	.....	.....	.....	.....	N.W.	Clear.	
27	.....	.....	.....	.....	N.W.	Partly cloudy.	Prevailing wind, N. W.
28	12 m.	Night.	.38	.....	S.W.	Cloudy.	
29	.....	.....	.....	.....	N.W.	Partly cloudy.	5th, short, heavy thunder shower, accompanied by very strong wind.
30	.....	.....	.....	.....	N.W.	Clear.	
Sum....	.....	.....	1.14				

Digitized by Google

METEOROLOGICAL SUMMARY

	Average temperature.		Precipitation.*		Snow in inches.		No. days .01 inch precipitation.		1898–1899.			
	July 1, 1895, to July 1, 1899.	1898–1899.	Average, July 1, 1895, to July 1, 1899.	1898–1899.	Average, July 1, 1895, to July 1, 1899.	1898–1899.	Average, July 1, 1895, to July 1, 1899.	1898–1899.	Prevailing wind direction.	Days clear.	Days partly cloudy.	Days cloudy.
July	69	70	3.97	1.75	.....	.....	10	9	S. E.	12	14	5
August	67	69	3.50	5.32	.....	.....	9	12	S. W.	9	15	7
September	60	61	4.44	3.57	.....	.....	8	7	S. W.	14	10	6
October	48	50	3.77	7.62	.....	.....	8	10	S. W.	8	12	11
November	38	38	5.70	5.19	6.	15.5	12	10	N. W.	7	12	11
December	25	25	3.07	2.43	7.	6.5	7	8	W.	6	21	4
January	21	22	4.07	6.70	20.	17.0	6	6	W. N. W.	7	18	6
February	24	22	3.22	2.01	18.	21.5	7	9	N. W.	7	14	7
March	32	29	4.36	4.76	14.	21.5	10	13	N. W.	11	15	5
April	44	44	2.56	1.38	2.	.....	8	6	N. W. & S.	17	8	5
May	56	55	3.01	1.68	.....	.....	10	8	S. E.	9	14	8
June	64	66	3.84	1.14	.....	.....	10	9	N. W.	7	18	5
Sum	550	551	45.5	43.6	67.	82.	105	107	N. W.	114	161	80
Mean	45.8	45.9										

* Including rain, hail, sleet, and melted snow in inches.

Digitized by Google

PUBLICATIONS OF EXPERIMENT STATION

The following publications of the station are available for distribution:

No. 2. Feeding Experiments.
No. 3. When to Cut Corn for Ensilage.
No. 4. The Science and Practice of Stock-Feeding.
No. 5. Fertilizers and Fertilizing Materials.
No. 6. Experiments with Fertilizers.
No. 7. Test of Dairy Apparatus.
No. 8. Feeding Experiments. Part 1. Principles of Feeding. Part 2. Corn Meal, Middlings, Shorts, and Cotton-Seed compared.
No. 9. Effect of Food upon Milk.
No. 10. Co-operative Fertilizer Experiments.
No. 11. Pig Feeding. Part 1. Results of Feeding Skim Milk and Corn Meal versus Corn Meal and Middlings. Part 2. Digestion Experiment.
No. 12. Fertilizer Experiments.
No. 14. Ensilage in Dairy Farming.
No. 15. Patent Cattle Foods.
No. 16. Effect of Food on Composition of Butter Fat.
No. 17. Stock Feeders' Guide.
No. 18. Effect of Food on Milk.
No. 19. Spraying Apples and Pears against Fungi.
No. 20. Effect of Food on Milk. Feeding with Fats.
No. 21. Farm-yard Manures and Artificial Fertilizers.
No. 22. Prevention of Potato Blight.
No. 23. Some Dangerous Fruit Insects.
No. 24. The Flow of Maple Sap.
No. 25. The Composition of Maple Sap.
No. 26. Analyses of Fertilizers and Wood Ashes.
No. 27. Spraying Experiments in 1894.
No. 28. Remedies for the Horn Fly.
No. 29. Remedies for Flea Beetles.
No. 30. An Experiment in Road Making.
No. 31. Seventh Annual Report. 1895.
No. 32. Studies of Maple Sap.
No. 33. Two Shade-Tree Pests.
No. 34. Surface and Sub-Irrigation out of Doors.
No. 35. The Codling Moth and the Apple Maggot.
No. 36. Analyses of Three Common Insecticides.
No. 37. Crimson Clover.
No. 38. The Tent Caterpillar.
No. 39. The Army Worm.
No. 40. Eighth Annual Report 1896.
No. 41. Potatoes: Varieties, Fertilizers, Scab.
No. 42. Part 1. Tomato Growing in New Hampshire. Part 2. Notes on Tomato Breeding.
No. 44. The Canker Worm.
No. 45. Fruit and Potato Diseases.
No. 46. Part 1. An Experiment with a Steam Drill. Part 2. Methods of Road Maintenance.
No. 48. Ninth Annual Report. 1897.
No. 50. Dehorning Cattle.
No. 51. Sweet Corn for New Hampshire.

Digitized by Google

No. 52. Growing Muskmelons in the North.
No. 53. The Farm Water Supply.
No. 54. The Winter Food of the Chickadee.
No. 55. The Feeding Habits of the Chipping Sparrow.
No. 56. Poisonous Properties of Wild Cherry Leaves.
No. 57. Forage and Root Crops.
No. 58. Cost of Raising Calves.
No. 59. Tenth Annual Report. 1898.
No. 60. Green Corn under Glass.
No. 61. Inspection of Fertilizers in 1898.
No. 62. Forcing Pole Beans under Glass.
No. 63. Third Potato Report.
No. 64. The Forest Tent Caterpillar.
No. 65. Notes on Apple and Potato Diseases.
No. 66. Experiments in Pig Feeding.
No. 67. The Spiny Caterpillar.
No. 68. Eleventh Annual Report. 1899.
First Annual Report. 1889.
Second Annual Report. 1890.
Fifth Annual Report. 1893.

Digitized by Google

BULLETIN

OF THE

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

1899

NUMBERS 60 TO 68

AND

ELEVENTH ANNUAL REPORT

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

Digitized by Google

CONTENTS

	Page
Green corn under glass:	1
The house and methods of treatment	8
Varieties	13
Summary	15
Inspection of fertilizers in 1898:	17
List of towns visited	20
List of manufacturers	21
Composition of fertilizers collected by State Board of Agriculture in 1898	22
Brands of fertilizers sampled but not analyzed	27
Forcing pole beans under glass:	29
Culture	31
Varieties	32
Summary	36
Third potato report:	37
Potatoes in Coös county	40
Comparison of varieties of potatoes	45
Tests of varieties in 1898	48
Notes on varieties	49
Reports from correspondents	53
Potato culture	70
Remarks	73
The Forest Tent caterpillar:	75
Life history	77
Habits of the caterpillars	81
Habits of the moths	87
Abundance and injuries	88
Dates of transformation	88
Descriptions of larval stages	89
Names	90
Natural enemies	90
Remedial measures	92
Notes on apple and potato diseases in 1898:	99
Potato scab	101
Potato blights or rusts	104
Apple diseases	106
Bordeaux mixture	107

Digitized by Google

CONTENTS.

Experiments in pig feeding: 109
Pumpkins, raw and cooked; apples and pumpkins; cornmeal and bran; cornmeal 111
Bran, fermented and unfermented; bran and cornmeal; cornmeal 116
Corn and cobmeal; corn on the ear 120
The Spiny Elm Caterpillar: 123
Life history 126
Food plants 131
Broods and hibernation 132
Feeding habits of the butterfly 135
Popular names of the butterfly 135
The caterpillars not poisonous 136
Geographical distribution 136
Abundance and injuries 137
Natural enemies 138
Predaceous insects 140
Remedies 140
Banding trees is useless for these caterpillars . . 141
Eleventh annual report: 143
Annual statement 145
Supplementary statement 146
Report of vice-director 147
Department of Horticulture 151
Department of Agriculture 154
Department of Entomology 157
Department of Bacteriology 158
Department of Meteorology and Agricultural Engineering 164
Meteorological tables 167
Publications of the Experiment Station 193

Digitized by Google

Sci 1636.35

Bulletin 69 January, 1900

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE INSPECTION OF FERTILIZERS

IN 1899

IN CO-OPERATION WITH THE STATE BOARD OF AGRICULTURE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

Digitized by Google

HARVARD COLLEGE
JUN 6 1930
LIBRARY

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL.

HON. JOHN G. TALLANT, *Chairman,* Pembroke.
HON. GEORGE A. WASON, New Boston.
CHARLES W. STONE, A. M., *Secretary,* Andover.
HENRY W. KEYES, A. M., Haverhill.
PRES. CHARLES S. MURKLAND, *ex officio,* Durham.

THE STATION COUNCIL.

PRES. CHARLES S. MURKLAND, A. M., PH. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director* and *Chemist.*
CHARLES H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
FRANK WM. RANE, B. AGR., M. S., *Horticulturist.*
CHARLES WM. BURKETT, M. S., *Agriculturist.*
FREDERICK S. JOHNSTON, B. S., *Associate Agriculturist.*

ASSISTANTS.

WILLIAM F. FISKE, *Assistant Entomologist.*
CLARENCE W. WAID, B. S., *Assistant Horticulturist.*
ROSCOE H. SHAW, B. S., *Assistant Chemist.*
HARRY A. CLARK, B. S., *Assistant Chemist.*
HARRY P. RICHARDSON, B. S., *Assistant in Agriculture.*
FREDERICK C. KEITH, *Clerk.*

Digitized by Google

FERTILIZERS

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS, 1899.

	Cents per lb.
Nitrogen in ammonia salts	15.0
" nitrates	12.5
" dry and fine ground fish, meat, and blood, and in high grade mixed fertilizers	14.0
" in cotton-seed meal, linseed meal, and castor-pomace	12.0
" fine ground bone and tankage	14.0
" medium ground bone and tankage	10.0
Phosphoric acid soluble in water	4.5
" " soluble in ammonium citrate (reverted)	4.0
" " in fine ground bone and tankage	4.0
" " in medium ground bone and tankage	4.0
" " in fine ground fish, cotton-seed meal, linseed meal, castor-pomace, and wood ashes	4.0
" " insoluble in mixed fertilizers	2.0
Potash as sulphate free from chlorides and in wood ashes	5.0
" " muriate	4.25

The above values are based on the wholesale market price for the materials, when sold in large lots at the principal trade centers in New England. The valuation of a ton of any mixed fertilizer based on the above figures will usually fall ten dollars below the retail price at the local agency. This varia-

Digitized by Google

EXPERIMENT NO. I

MONŒCIOUS *vs.* PERFECT FLOWERS

Among the interesting things found out in studying the muskmelon is that while we have considered this fruit to be monœcious, generally speaking, I find it is perfect. Out of ninety-three varieties examined the pistillate or female blossoms contained stamens and pollen in eighty-three. The remaining ten to all appearances were monœcious, and consist entirely of the larger varieties, viz., Nos. 3, 37, 43, 44, 54, 56, 60, 76, 82, and 87. For names see pages 31-33.

My attention was first called to the fact when examining the so-called pistillate flowers of the forcing house when planning an experiment in hand pollination and crossing.

The forcing house melons being in advance of those outside, the experiment began here. Upon examining the first pistillate flower, I was surprised to find what I took to be well-developed stamens.

Further examination with the other varieties in the house also pointed to a similar conclusion. Upon still further investigation with the microscope, I found that not only were they well developed but that these stamens were very prolific with pollen. On comparing them with those of the pistillate flowers, in each case coming from the same varieties, the pollen was equally as abundant.

Thinking this might be a freak due to the unusual conditions of the forcing house, or, second, a mistake as regards the purported facts, further examination was carried on as follows: In order to settle the first question, these same varieties were examined out of doors as they came into bloom and were found not to vary in the least.

Being further interested in the question, Mr. A. Z. Norcross, an advanced student, was delegated in the summer of 1898 to examine all of the varieties, which resulted in the data given above. Upon consultation into the literature upon the subject as far as I was able to go, the fact is not recognized. Gray's Manual of Botany, "The flowers are dicœcious or monœcious";

Digitized by Google

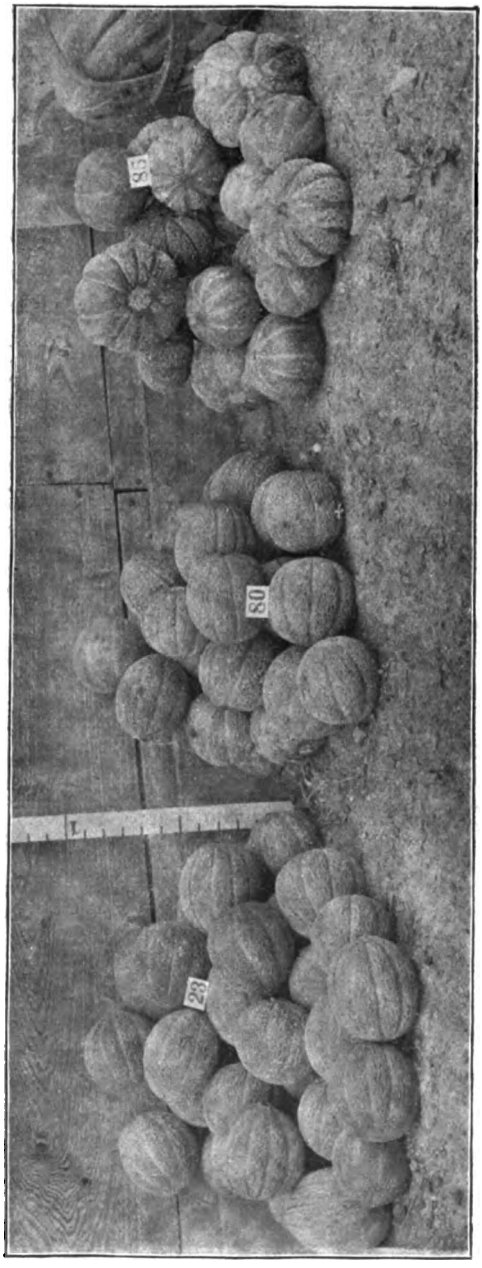


FIG. 2.

Digitized by Google

Nicholson's Dictionary of Gardening, "The flowers are monœcious and are produced in the axis of the leaf stock, the males being far the most numerous of the two sexes"; Bailey's Forcing Book, "Melons are monœcious, that is, the sexes are borne in separate flowers on the same plant; the first flowers to open are always males or staminate and it may be two weeks after these blossoms appear that the females or pistillate begin to form."

In order to determine whether the pollen from these staminate flowers is fertile or prepotent, many flowers were covered just previous to opening and then pollinated with their own pollen, artificially, omitting some to see if they were capable of self-fertilization. We were successful in setting the fruit through the artificial means, although out of twenty-four blossoms covered but not hand pollinated no fruit set. This work has been carried on now for two seasons, and the present season fruit has been produced from the seed taken from the fruit which was fertilized with pollen produced in the so-called pistillate flower. To what extent the pollen of the pistillate flower is effective upon the fruit itself I am not prepared to state, but a close examination of the pistillate flower and the method of insect visitation leads me to think that the pistil, which is tri-lobed, is more easily self-fertile than otherwise. Further investigation is needed to determine various points. That the muskmelon is monœcious, however, needs some qualifications, and especially where the practical bearing comes is that the horticulturist in crossing these fruits should remember that the majority of our cultivated varieties, and practically all of the smaller sized varieties, contain perfect flowers.

EXPERIMENT NO. II

PICKING TIME

There seems to be no general rule for the best time to pick muskmelons equally applicable to all varieties. To allow them to ripen or turn yellow upon the vines usually results in a loss

Digitized by Google

of the fine flavor and desirable texture of the flesh. With most of the smaller or Gem type, and many of the medium class, as soon as the melon begins to ripen it cracks about the stem more or less. As soon as this takes place and the fruit comes off easily leaving the stem behind, the fruit should be gathered and put in a cool place or sent to market.

This cracking about the stem is very noticeable with some varieties from their excreting a few drops of bright red or salmon-colored juice.

In some of the larger varieties the stem does not separate from the fruit, or else when it does it leaves too large a hole in the rind. In such cases it is best to cut the stem leaving the lower portion attached to the fruit. Perhaps the most desirable method of telling when these larger melons are ripe is to watch carefully for the first signs of yellowing, which usually appear first in the middle portion of the fruit. As soon as these traces of yellow are seen they should be picked. The conditions of the weather have much to do with the fruit ripening. On hot days fruit ripens very quickly and it is often advisable to make two pickings, one early in the cool portion of the morning and again in the afternoon. An experienced person can usually tell by the general appearance and sense of smell of the fruit; even with the small Gem melons, with a little experience, one can pick out the ripe melons without looking at the characteristic separations about the stem end. With the dark-skinned varieties it is perhaps more difficult, but even here the general remarks already made apply equally well.

While on this subject we may also be asked, how is the consumer who purchases this fruit upon the market to know whether it is ripe or not? This question is not an easy one and somewhat problematical. With the small or Gem melons, they should not have been picked until the stem separates from them; hence if the stems are on they undoubtedly were picked green and are of doubtful value. It will be noticed, however, that many of the earlier of these fruits that come from the South to our northern markets do have their stems on and a portion of them may be fair flavored for that season of the

Digitized by Google

year; the way shown me by a large dealer as the best method of detecting the superior fruits is to select those stemless, as already described, or those from which the stem easily separates; then by smelling of the fruit at the stem end, the aroma present will indicate their value.

If none is detected, or a very slight one, the fruit will be of little value. In case the stem is already removed the same test is applied, but the fruit should be scraped with a knife or, more commonly, the thumb nail, where the stem was severed, and this aids in the detection of aroma and hence flavor. With the larger varieties the general appearance and sense of smell are perhaps the only index as to quality.

Each variety has its characteristics and the more one acquaints himself with them the better judgment he has as to picking time. A good muskmelon picked and marketed at the proper time usually is delicious, while if too green or allowed to over-ripen it becomes a rebuke to the melon trade.

EXPERIMENT NO. III

TRANSPLANTING PLANTS STARTED EARLY *vs.* SOWING SEED OUT OF DOORS

This experiment as planned and conducted was to determine the comparative yield of the two methods of growing muskmelons and to determine if the transplanted plants produce fruit enough earlier to compensate for the extra care necessarily given them.

A large plot was set aside for this experiment and the three varieties shown in Fig. 2 were used. These varieties are early and found to be very desirable in our markets. Two rows consisting of fourteen hills of the transplanted and one row planted with seeds were devoted to the No. 23 Rose Gem. A similar planting with two rows of the seed was made of the No. 80, Netted Gem, and with No. 85, True Jenny Lind, but one row was transplanted and two planted with seed.

Digitized by Google

The planting and transplanting was made out of doors, on June 1, the hills being similarly prepared. The transplanted plants were obtained by starting the seed in thumb pots and then transplanting into a four-inch pot, from these hardening off in a cold frame, then transplanting.

TABLE I.

Comparative yield of transplanted and seed sown in the hill for the whole season.

Method of planting.	Rose Gem. Average per hill.	Netted Gem. Average per hill.	True Jenny Lind. Average per hill.
Transplanted	13 1-2 fruit.	15 2-9 fruit.	10 1-2 fruit.
Seed	18 4-5 "	15 4-5 "	12 3-10 "
Average yield.....	16 1-8 fruit.	15 1-2 fruit.	11 2-5 fruit.

It will be seen that with each variety those hills planted with seed outyielded the others when the whole season's yield is considered.

TABLE II.

Comparative earliness of yield of transplanted and seed sown in hills to September 5th. Yield in each case from ten hills.

Number.	VARIETY.	Aug. 23.	Sept. 1.	Sept 2.	Sept. 5.	Total.	Gain.
23	Transplanted	2	5	11	12	30	18
23	Seed			3	9	12	.....
80	Transplanted			10	13	23	17
80	Seed			2	4	6	.....
85	Transplanted		2	6	2	10	1
85	Seed			3	6	9	.....

This table shows that the transplanted hills were earlier, and up to September 5 were in advance from point of yield.

From September 5 on, however, the planted hills outyielded, as is shown in Table I.

Digitized by Google

Whether this extra early yield will pay for the extra labor can only be determined by the conditions and facilities of the grower.

Generally speaking, it is doubtless a questionable undertaking, but in a few instances might be profitable.

The experiment in point of earliness shows but comparatively few fruits and but ten days in the extreme, and but a few days in the majority of cases, in favor of the transplanted plants.

EXPERIMENT NO. IV

PINCHED *vs.* UNPINCHED VINES

This experiment was planned and conducted to determine the value of pinching or heading-in the melon vines, as compared with allowing them to take their natural growth. The following table represents the plot used for this experiment. In row "B" the vines were nipped when they were three feet long and then the laterals were again nipped or pinched in, not allowing over one or two fruit to set on each.

In row "D" the main vine was pinched but no laterals; the others were allowed to take their natural growth.

TABLE III.

Results from Pinched and Unpinched Vines.

VARIETY.	A.		B.		C.		D.		E.		Hills.
	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	
Rose Gem	12	12.9	19	19 5	11	12.8	17	17.3	10	13.5	1
Rose Gem	11	13.4	15	17.5	9	10 8	16	18.5	15	15 4	2
Rose Gem	21	22.8	17	16.8	14	12.4	26	21.1	16	15.4	3
Netted Gem	20	18.2	*	*	10	11.1	13	15.0	15	18.3	4
Netted Gem	17	28.8	13	16.6	22	21.5	13	12.4	14	15.6	5
Netted Gem	19	21.8	22	20 3	10	14.8	7	9.4	21	20.0	6
True Jenny Lind	12	18.8	*	*	11	16.6	12	16.2	7	12.6	7
True Jenny Lind	20	22.7	14	17 2	12	14.9	7	9.2	11	12.1	8
True Jenny Lind	8	8.0	14	17.6	12	17.0	12	15.4	13	16.5	9
Netted Gem	18	13.6	11	11 3	15	13.6	11	9.4	18	15.1	10
Average per hill	15.8	18.1	15.6	17.1	12.6	14.5	13.4	14.4	14	15.5	

* Absent.

Digitized by Google

It will be noted that the experiment shows little if any gain. In fact, if the time required in executing the work be taken into consideration the experiment would indicate a loss; especially is this indicated in row "D." Row "B," where both the main vine and laterals were nipped, shows better returns, but even here the work necessitated is more than in row "D."

The conclusion points to there being little if any gain from pinching or heading-in the muskmelon when grown out of doors.

EXPERIMENT NO. V

REMOVING MALE BLOSSOMS

The fact that there is such an abundance of the staminate flowers and that they appear so long in advance of the pistillate or perfect ones lends an air of mystery as to their usefulness.

The following experiment was undertaken to see if by removing the staminate flowers any effect could be noticed in the production of fruit. Row "A," Table III, was selected for this experiment and the row was daily gone over, except in rainy weather, until August 18.

The exact number of flowers was not counted, but under ordinary conditions from 150 to 300 of these staminate flowers were picked daily from the ten hills. The results, as indicated in Table III, show that this row ("A") gave the largest yield both as to number and average weight of fruit. When we take into consideration the great amount of labor necessitated, however, it cannot be recommended as practical.

EXPERIMENT NO. VI

NEW FOREIGN VARIETY

We were fortunate in getting from the United States department of agriculture samples of muskmelon seeds from each of the new introductions included in "Inventory No. 1"; "Foreign Seeds and Plants."

Digitized by Google

Unfortunately the past season was extremely dry and many of the seeds did not germinate readily. Out of about one hundred that fruited, only one approached anything of special value. This variety was "Lida," No. 66 (The United States department number), from Moscow, Russia. Collected by Prof. Hansen, February, 1898.

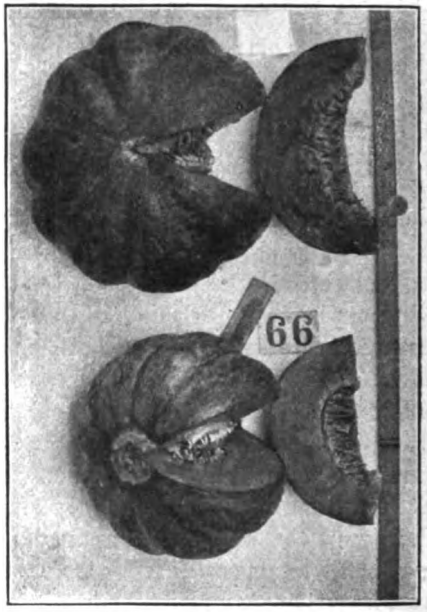


FIG. 3. VARIETY "LIDA" (Russian).

Figure 3 is a photograph of the fruit grown here at the station. The fruit is medium size, not netted, round to oval, strongly ribbed. The flesh is a deep salmon, rich, juicy, and delicate. Skin thin, flesh thick, small cavity. Matures in New Hampshire,—very promising.

Digitized by Google

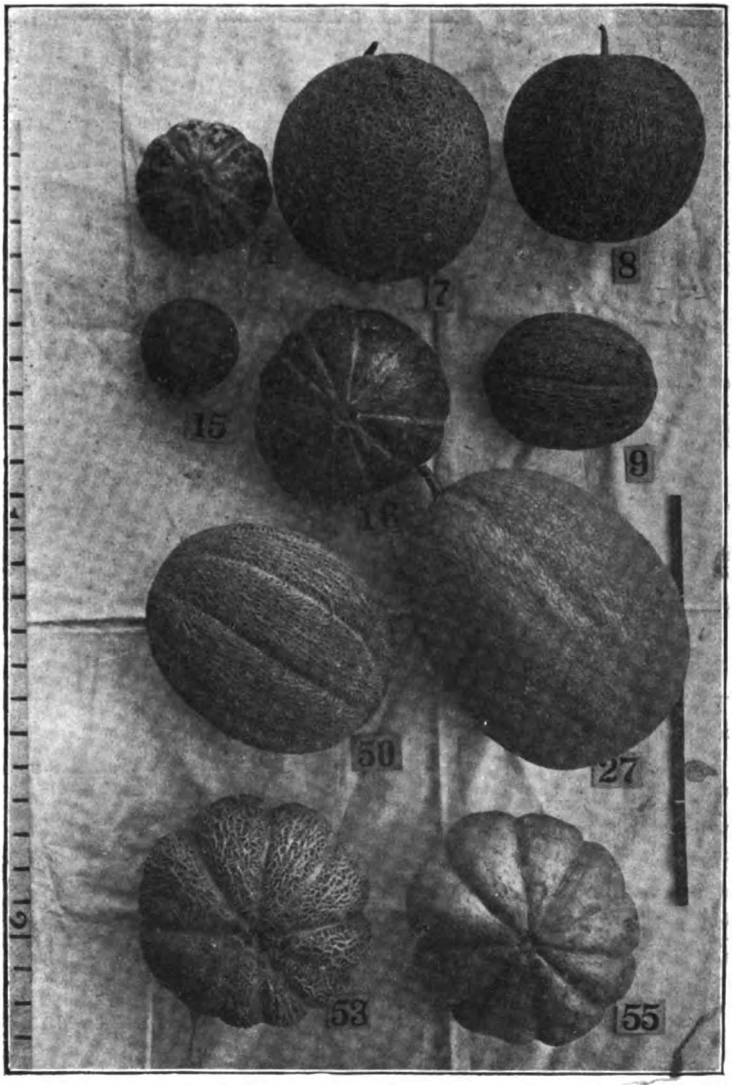


FIG. 4. VARIETIES OF MUSKMELONS.

1. Apple-shaped Cantaloupe.
7. Cosmopolitan.
8. Netted Beauty.
9. Golden Gem.
15. Mango.
16. Emerald Gem.
27. New Hybrid.
50. Champion Market.
53. Chicago Nutmeg.
55. Irondequoit.

Digitized by Google

EXPERIMENT NO. VII

VARIETY TEST: MUSKMELONS IN THE NORTH

The results of two additional seasons with these same varieties together with the later introductions, make this the second report more complete. The first report, "New Hampshire Experiment Station Bulletin No. 52," contains figures and descriptions of all varieties numbering up to sixty, with the exception of illustrations of numbers 1, 7, 8, 9, 27, 50, 53, and 55. Figure 4 in this bulletin contains these missing numbers and also a correction of numbers 15 and 16. They should be as represented in Fig. 4 of this report.

The season of 1898 was ideal for all vines, the muskmelon included. The results from this season we believe can be depended upon to set forth the possibilities of the melon in the North. Melons that did not ripen in 1898 cannot be relied upon to mature in northern climates.

The general conditions of culture, etc., as outlined in Bulletin 52, were carried out with both crops. The land selected was a lightish clay loam, which had grown a crop of onions the previous year, and was therefore in good cultivation. A cultivated crop with a heavy application of barnyard manure preceded the onion crop, which was itself fertilized with a good dressing of commercial fertilizer. In the spring the plot was harrowed into a very mellow condition, marked out five by six feet, and each hill received a large shovelful of rich compost and a handful of bone meal. The hills were then thoroughly mixed with this plant food and planted June 1. There were at least two hills of each variety planted and ninety-five in all.

The hills were thinned to three plants each on July 12. Cultivation was kept up at frequent intervals until the plants covered the ground. During extremely dry times the melons were irrigated from the main college water system. Not much was gained, however, as a neighboring plot, under similar conditions but without water, was equally productive. The melon appears able to withstand drouth as well as almost any garden

Digitized by Google

crop. The plants were allowed to run at will until the ground was well covered, when on August 23 the vines were nipped back or headed-in sufficiently to allow picking of the fruit and general note-taking.

In 1898 the frost held off until September 23; in 1899, until September, and on the following days all the fruit was harvested and notes completed.

The striped squash beetle (*Diabrotica vittata*) was very numerous and troublesome. We found, however, that old slaked lime and gypsum were equally as valuable as tobacco dust in keeping them away. When they were very thick the young plants were completely dusted or coated with these substances. Even when tobacco dust is used it is necessary to watch the young plants closely and repeat the application whenever necessary. This trouble however does not last long, but for a week or so until the plants get a few true leaves, it must be attended to.

The specimens illustrating each variety, as shown in the figures, were picked September 12, thus giving each an opportunity to mature and be in prime condition. Each was selected as a type of its variety.

EXPLANATION OF TABLES IV AND V

In each case the figures represent the yield from two hills; where, as in a few instances, but one survived, the yield was doubled to make all varieties comparable. In the column headed "Date of ripening," the date recorded is that when the variety could be considered as beginning to ripen generally. In several cases one fruit of a variety ripened a week or so before any other. An asterisk has been used to indicate this fact. In Table V accurate measurements and general comparative data of all varieties grown are given.

For convenience to the reader, the full address of the various seedsmen are given in full:

Burpee, W. Atlee Burpee, Philadelphia, Pa.; J. & S., Johnston & Stokes, Philadelphia, Pa.; Breck, Joseph Breck & Sons, Boston, Mass.; Henderson, Peter Henderson & Co., New York

Digitized by Google

city; Livingston, The Livingston Seed Co., Columbus, Ohio; Gregory, J. J. Gregory & Sons, Marblehead, Mass.; Buckbee, H. W. Buckbee, Rockford, Ill.; Salzer, John A. Salzer Seed Co., La Crosse, Wis.; Ferry, D. M. Ferry & Co., Detroit, Mich.; Farquhar, R. & J. Farquhar & Co., Boston, Mass.; Dreer, Henry A. Dreer, Philadelphia, Pa.; May, L. L. May & Co., St. Paul, Minn.; Eastman, Eastman Seed Co., East Sumner, Me.; Landreth, David Landreth & Sons, Philadelphia, Pa.; W. & D. Weeber & Don, New York City; Vaughan, Vaughan's Seed store, Chicago, Ill.

Digitized by Google

TABLE IV.—COMPARISON OF VARIETIES OF MUSKMELONS

Yield calculated from two hills of each variety. Hills five by six feet apart.

Number.	VARIETY.	Date of ripening.	Number of fruit ripened.	Total weight of ripe fruit, in pounds.	Average weight of ripe fruit, in pounds.	Number of fruits not ripened.	Total weight of fruit not ripened.	Average number of ripe fruit per acre.	Seedsmen. (Full address on pages 29, 30.)
1	Apple-shaped Cantaloupe	.....	.....	.....	.....	18	16.0	.....	Burpee.
2	Triumph	.....	.....	.....	.....	12	11.7	.....	"
3	Extra Early Grand Rapids	*Sept. 8	8	34.0	4.5	5	20.6	5,808	"
4	Melrose	17	7	13.5	2.0	15	26.6	5,082	"
5	Cannon Ball	17	3	6.8	2.3	21	47.4	2,178	"
6	Green-fleshed Osage	15	3	5.7	1.9	27	52.8	2,178	J. & S.
7	Cosmopolitan	*15	5	17.9	3.6	9	33.5	3,630	Burpee.
8	Netted Beauty	22	6	7.9	1.2	18	38.7	4,356	J. & S.
9	Golden Gem	2	11	10.5	1.0	16	13.7	7,986	"
10	Captain	6	17	26.9	1.6	7	5.5	12,342	"
11	No. 88	6	17	14.5	0.8	8	6.6	12,342	"
12	Lone Star	.....	.....	.....	.....	8	27 3	.....	"
13	Miller's Cream Nutmeg	Sept. 22	6	24.6	4.1	11	28.5	4,356	"
14	Jersey Belle	*15	9	26 3	3.0	7	10.8	6,534	"
15	Mango	2	48	22.9	0.5	34	17.3	34,848	Breck.
16	Emerald Gem	10	20	38.8	1.9	6	53.0	14,520	"
17	Hackensack	*19	7	33.0	4.7	5	18.8	5,082	"
18	Newport	6	18	22.3	1.2	2	1.5	13,068	Henderson.
19	Perfected Delmonico	19	9	17.9	2.0	7	13.6	6,534	"
20	Banquet	17	6	11.6	2.0	20	35 9	4,356	"
21	Market	19	2	10.9	5.4	11	32.4	1,452	Livingston.
22	Tip-Top	19	4	12.1	3.0	16	47.2	2,904	"
23	Rose Gem	8	20	19.5	1.0	14	15.4	14,520	"
24	Sill's Hybrid	.....	.....	.....	.....	.....	.....	.....	Gregory.
25	Long Island Beauty	*Sept. 9	8	39.4	4.9	2	7.0	5,808	"

Digitized by Google

TABLE IV.— *Continued.*

Number.	VARIETY.	Date of ripening.	Number of fruit ripened.	Total weight of ripe fruit, in pounds.	Average weight of ripe fruit, in pounds.	Number of fruits not ripened.	Total weight of fruit not ripened.	Average number of ripe fruit per acre.	Seedsmen.
26	Six Oaks Cantaloupe	Sept. 15	11	32.0	3.0	9	22.8	7,986	Gregory.
27	New Hybrid	19	1	4.6	4.6	9	22.8	726	Buckbee.
28	Triumph	22	5	16.5	3.3	8	26.0	3,630	"
29	Earliest Ripe	9	15	17.2	1.1	8	5.1	10,890	Salzer.
30	Cosmopolitan	8	12	34.5	2.9	8	16.8	8,712	Ferry.
31	Ironclad	*15	7	22.2	3.1	12	22.0	5,082	Buckbee.
32	Satisfaction	8	14	44.0	3.1	5	7.1	10,164	Farquhar.
33	Jenny Lind	9	15	19.6	1.3	3	3.1	10,890	Dreer.
34	Columbus	17	4	17.0	4.2	5	18.8	2,904	"
35	Pineapple	9	10	24.1	2.4	8	10.2	7,260	May.
36	Seedling—Hybrid Nutmeg								Spalding.
37	Granite State	Sept. 2	7	37.9	5.6			5,082	Eastman.
38	Carmes	15	2	10.3	5.1	8	37.4	1,452	Henderson.
39	Shumway's Giant	*19	6	31.7	5.3	9	27.3	4,356	Gregory.
40	Montreal Nutmeg	22	7	34.9	5.0	5	19.1	5,082	"
41	Early Nutmeg	15	14	34.8	2.5	5	8.3	10,164	"
42	Osage	15	7	30.7	4.4	6	16.5	5,082	"
43	Bay View	*17	7	29.2	4.1	4	19.6	5,082	"
44	Delmonico	6	6	34.5	5.7	4	15.9	4,356	"
45	Extra Early Hackensack	9	13	44.7	3.4	3	4.4	9,438	"
46	New White Japan	6	10	39.9	2.1	3	2.4	13,794	"
47	Skillman's Fine Netted	10	11	24.1	2.2	6	10.5	7,986	"
48	Christiana	8	15	28.5	1.9	6	7.7	10,890	"
49	Extra Early Cantaloupe	Aug. 30	9	22.9	2.5	4	8.8	6,534	"
50	Champion Market	Sept. 8	7	21.1	3.0	5	14.6	5,082	"
51	Banana	22	4	14.0	3.5	5	9.5	2,904	"
52	Surprise	15	14	50.2	3.4	3	9.2	10,164	"
53	Chicago Nutmeg	9	10	49.4	5.0	4	10.2	7,260	"

Digitized by Google

54	Long Yellow	Sept.	8	11	83.9	7.6	1	1.5	7,986	Gregory.
55	Irondequoit		9	12	41.5	3.4	4	9.9	8,712	"
56	Casaba		15	8	28.9	3.6	6	20.4	5,808	"
57	Golden-Netted Gem		8	24	33.8	1.4	8	6.8	17,424	"
58	Bird Cantaloupe		9	11	31.9	2.9	9	10.1	7,986	Landreth.
59	Missouri		12	9	30.2	3 3	4	8.2	6,534	"
60	Large White French		22	2	14.5	7.0	9	41.9	1,452	"
61	Netted Nutmeg		15	8	21.0	2.6	5	24.4	5,808	"
62	Large Black Paris		*22	4	19.0	4.7	10	51 6	2,904	"
63	Anne Arundel		*14	13	39.3	3.0	5	15 2	9,438	"
64	Atlantic City		17	3	13.1	4.4	14	38.1	2,178	"
65	Improved Jenny		12	12	34.6	2.9	1	4.8	8,712	"
66	Acme		8	10	28.8	2.9	3	6.6	7,260	"
67	Citron		*19	10	39.8	4.0	4	11.0	7,260	"
68	Ward's Nectar		17	16	31.2	2.0	7	10.4	11,616	"
69	McCotter's Pride		24	1	4.6	4.6	12	55.3	726	Ferry.
70	Shippers' Delight		6	18	15.7	0.9	12	9 4	13,068	J. & S.
71	Togoodo						1	0.9		"
72	Ivy Gem	Sept.	12	12	46.3	3.9	13	21 7	8,712	"
73	Golden Eagle		*17	7	14.3	2 0	17	28.0	5,082	Burpee.
74	Arlington Nutmeg		12	8	37.0	4 6	3	10.9	5,808	Farquhar.
75	Honey Drop		19	6	20.6	3.4	10	22.2	4,356	"
76	Cassabah		*15	6	29.2	5.0	4	20.5	4,356	Dreer.
77	Blenheim's Orange		24	1	2.6	2.6	14	21 9	726	W. & D.
78	Hero of Lockinge						10	17.5		"
79	Conqueror of Europe	Sept.		2	2.8	1.4	14	27.3	1,452	"
80	Netted Gem		6	22	26.6	1.2	16	14.1	15,972	Burpee.
81	Queen of All		*15	11	38.1	3.4	7	26 5	7,986	Salzer.
82	Nectar of Angels		1	12	45.4	3.8	2	7.2	8,712	"
83	Buckbee No. 555						11	30.1		Buckbee.
84	Superior	Sept.	17	11	23.9	2.1	15	28 6	7,986	Vaughan.
85	True Jenny Lind		*8	15	20.1	1.3	6	5.3	10,890	"
86	Giant Chicago Market		17	8	28.2	3.5	7	21.5	5,808	"
87	Improved Cantaloupe	Aug.	30	8	48.7	6.1	4	11.9	5,808	"
88	Oval Netted Nutmeg	Sept.	8	25	36.5	1.4	14	13.6	18,154	"
89	Southern Beauty		12	4	16.8	4.2	8	23.8	2,904	"
90	Montreal Nutmeg						10	67.9		"
91	Princess						24	69.0		"
92	Perfection	Sept.	8	8	32.4	4.0	14	36.5	5,808	"
93	Paul Rose		8	20	37.9	1.9	32	32.7	14,520	"
94	Round Netted Gem		1	18	23.3	1.3	11	11.8	13,068	"
95	Kinsman Queen		9	24	65.1	2.7	8	16.3	17,424	Banning.

* One fruit ripened earlier.

Digitized by Google

TABLE V.—CHARACTERISTICS OF EACH VARIETY.

Number.	VARIETY.	Shape.	Color of flesh.	Ribbed.	Nettedness.	Flavor.	Thickness of rind, in inches.	Thickness of flesh, in inches.	Size of cavity, in inches.
1	Apple-shaped Cantaloupe	Apple	Yellow	Ribbed	Not			1	1½×1½
2	Triumph	Oblong	Salmon	Not	Gray	Extra sweet		1	6 ×3
3	Extra Early Grand Rapids	"	Yellow	Shallow	Netted			1	5 ×3
4	Melrose	Round	Green	Not	Thickly	Gem type			3½×3½
5	Cannon Ball	"	"	Not	Netted				2½×2½
6	Green-fleshed Osage	Round to obl'g	"	Shallow	Slightly	Gem type			2½×2½
7	Cosmopolitan	Round	"	Not	Heavy				3½×3½
8	Netted Beauty	"	"	Not	Netted				3 ×3
9	Golden Gem	"	"	Not	"	Gem type			
10	Captain	Flattened	"	Shallow	"	"			2½×3½
11	No. 88	"	"	"	"	"			2 ×1½
12	Lone Star	Oblong	Yellow	Not	Slightly				
13	Miller's Cream Nutmeg	Round	"	Shallow	Netted				3 ×4
14	Jersey Belle	Flattened	Green	"	"	Gem type			2½×3½
15	Mango	Round	White	Not	Not	Acid			1 ×1½
16	Emerald Gem	"	Salmon	Not	Netted	Musky rich		1	1½×2
17	Hackensack	Flattened	Green	Deep	Heavy				3½×4½
18	Newport	Oblate	"	Shallow	Netted	Gem type			1½×2½
19	Perfected Delmonico	Round	Yellow	Not	"			1	×2½
20	Banquet	"	Rich yellow	Not	Heavy				×2½
21	Market	Flattened	Green	Deep	Netted	Good		1	2½ × 3
22	Tip-Top	Round to obl'g	Yellow	Shallow	Slightly	"		1	× 4
23	Rose Gem	Round	Green	Very shallow	Netted	Gem type		1	3½×3½
24	Sill's Hybrid	"	Salmon	Medium	"				× 2½
25	Long Island Beauty	Flattened	White	Deep	Heavy			1	3 × 3½

Digitized by Google

26	Six Oaks Cantaloupe	Flattened	Yellow	Shallow	Netted		½	1	3 ×3
27	New Hybrid	Oblong	"	Not	Slightly			1	4 ×6
28	Triumph	"	Salmon	Not	"		1½		3½×5½
29	Earliest Ripe	Flattened	Green	Shallow	Netted	Gem type			1½×2½
30	Cosmopolitan	Round	"	Not	Heavy	Very delicate			2½×3
31	Ironclad	Flattened	"	Shallow	Netted			1	3 ×3
32	Satisfaction	"	Yellow to salmon	"	Not				3½×3
33	Jenny Lind	"	Green	"	Netted	Gem type			
34	Columbus	Round	"	Not	"			1	4 ×5
35	Pineapple	Oval	"	Shallow	"				2½×3
36	Seedling—Hybrid Nutmeg								
37	Granite State	Elongated	Yellow to salmon	Deep	Netted	Good	½	1½	2½×7
38	Carmes	Flattened	Salmon	"	"				
39	Shumway's Giant	"	Light salmon	Shallow	Not	Peculiar	½	1½	4 ×4
40	Montreal Nutmeg	Round	Green	Very shallow	Netted	Good		1	3½×4½
41	Early Nutmeg	Flattened	Light green	Shallow	"	Very sweet			2½×3
42	Osage	Oblong	Salmon	"	"	"		1	4 ×5
43	Bay View	"	Green	Deep	"		½		4½×8
44	Delmonico	Oval	Rich salmon	Shallow	Slightly			1	4½×6
45	Extra Early Hackensack	Flattened	Light green	Deep	Thickly	Musky			3½×3
46	New White Japan	Round	"	Shallow	Slightly				3 ×3
47	Skillman's Fine Netted	"	Green	"	Thickly			1	4 ×4
48	Christiana	Flattened	Salmon	"	Netted	Very sweet		1	
49	Extra Early Cantaloupe	Oblong	Green	"	"	Gem type			3½×5
50	Champion Market	"	"	"	Thickly				3½×4
51	Banana	Banana	Yellow	Not	Not				2×14
52	Surprise	Flattened	Salmon	Deep	Slightly	Very sweet		1	3½×3½
53	Chicago Nutmeg	"	Green	Shallow	Coarse	Good		1	5 ×3½
54	Long Yellow	Elongated	Pale yellow	Deep	Netted	Fair early		1½	9 ×3
55	Irondequoit	Flattened	Yellow	Shallow	Not	Sweet		1	4 ×5
56	Casaba	Oval	Green	"	Netted	"		1	4 ×5½
57	Golden-Netted Gem	"	"	Very shallow	"	Gem type			3 ×3
58	Bird Cantaloupe	"	"	Shallow	"				2 ×3
59	Missouri	Flattened	Light green	"	"	Sweet			2½×3½
60	Large White French	Oblong	Yellow to salmon	Deep	"			1½	4 ×8
61	Netted Nutmeg	Oval	Green	Shallow	"	Sweet		1	4 ×5
62	Large Black Paris	Oblong	"	Deep	Slightly			1	4½×7
63	Anne Arundel	Oblong to oval	"	Very shallow	Netted				2½×3½
64	Atlantic City	Oblong	"	Shallow	"				3½×5½
65	Improved Jenny	Flattened	"	"	"			1	3½×4½
66	Acme	Oval	"	Very shallow	"			1	3 ×4½
67	Citron	Round	Salmon	Shallow	"	Good		1	3½×3½

Digitized by Google

TABLE V.—*Continued.*

Number.	VARIETY.	Shape.	Color of flesh.	Ribbed.	Nettedness.	Flavor.	Thickness of rind, in inches.	Thickness of flesh, in inches.	Size of cavity, in inches.
68	Ward's Nectar	Round	Green	Shallow	Netted				2½×3
69	McCotter's Pride	"	Salmon	"	"			1½	3×4
70	Shippers' Delight	Flattened	Green	"	"			2	2×3
71	Togoodo	Oval	Green to yellow						
72	Ivy Gem	Flattened	Salmon	Shallow	Not	Sweet			2½×3½
73	Golden Eagle	Round	Yellow to salmon	"	Netted	Good		1	2½×3
74	Arlington Nutmeg	Flattened	Pale green	Deep	"			1	3×3½
75	Honey Drop	Oblong	Yellow to salmon	Shallow	Not	Good		1	3×3
76	Cassabah	"	Green	"	Thickly			1	3×3
77	Blenheim's Orange	Round	Salmon	Not	"			1	2×2
78	Hero of Lockinge								
79	Conqueror of Europe	Round		Not	Netted				3×3½
80	Netted Gem	Oval	Green	"	"	Gem type			2½×2½
81	Queen of all	Oblong	Salmon	Shallow	Slightly				3×3½
82	Nectar of Angels	Round	Pale yellow	"	Thinly	Good		1	3×4
83	No. 555	"	Yellow to green	Not	Netted				3×3½
84	Superior	"	Green	Not	Thinly				2×2½
85	True Jenny Lind	Flattened	"	Shallow	Netted	Gem type			2×3½
86	Giant Chicago Market	Round	"	"	Course			1	3×3½
87	Improved Cantaloupe	Long	Yellow	Deep	Netted			1	
88	Oval Netted Nutmeg	Oval	Green	Very shallow	"	Gem type			2×2½
89	Southern Beauty	"	"	Shallow	"	Very sweet		1	3×3
90	Montreal Nutmeg	Flattened		Deep	"				
91	Princess	Oblong		Shallow	Thinly				
92	Perfection	Flattened	Pale yellow	Deep	Netted				
93	Paul Rose	Oval	Salmon	Very shallow	"	Extra		1	2½×4
94	Round Netted Gem	"	Green	Shallow	Course				2×2½
95	Kinsman Queen	Flattened	Salmon	"	Not	Good			1×2½

Digitized by Google

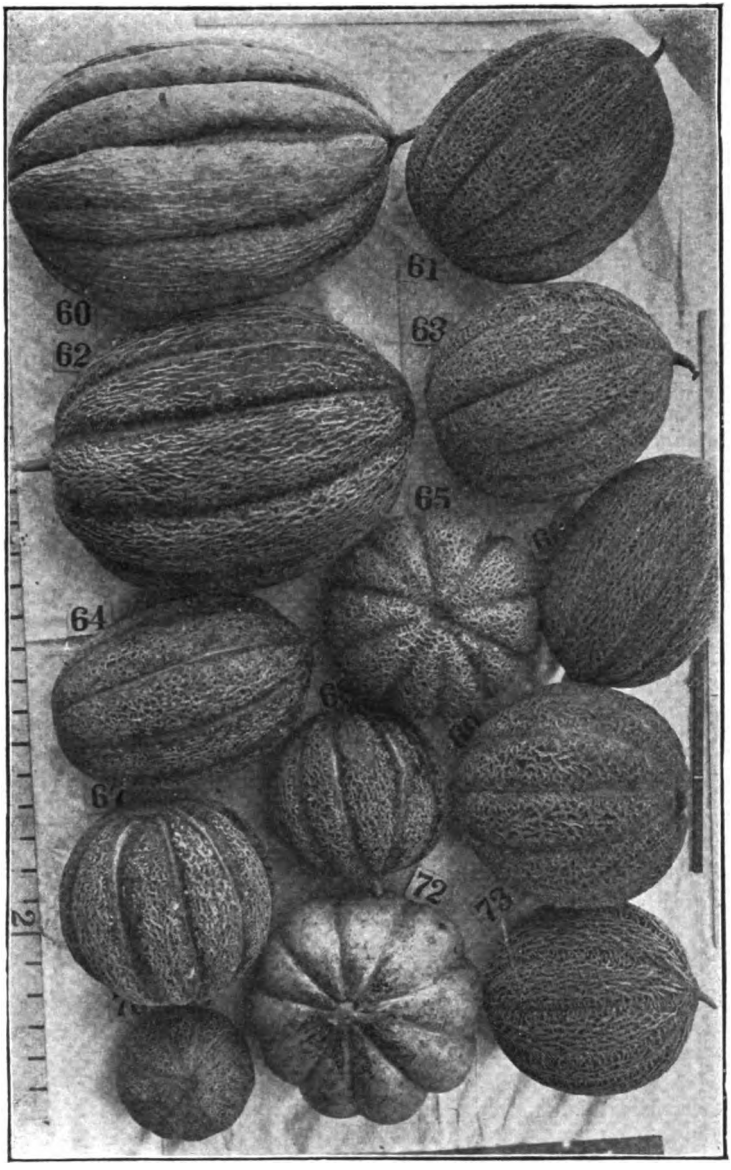


FIG. 5. VARIETIES OF MUSKMELONS.

60. Large White French.
61. Netted Nutmeg.
62. Large Black Paris.
63. Anne Arundel.
64. Atlantic City.
65. Improved Jenny.
66. Acme.
67. Citron.
68. Ward's Nectar.
69. McCotter's Pride.
70. Shipper's Delight.
72. Ivy Gem.
73. Golden Eagle.

Digitized by Google

NOTES ON VARIETIES

For general notes and illustrations upon varieties numbering from 1 to 60, consult Bulletin No. 52 of this station. A few illustrations were missed and are now given for the first time in Fig. 3, this bulletin. For exterior appearance of each of the following thirty-six varieties consult the photograph of each as shown in Figs. 5, 6, 7.

60. *Large White French* (Landreth). Oblong melon of large size, 7½ by 11½ inches. Color whitish green turning to yellow when ripe; flesh orange. Too late for the North.

61. *Netted Nutmeg* (Landreth). Round, fairly productive; dark green, ribbed, slightly netted, flavor sweet, regular in form, green flesh.

62. *Large Black Paris* (Landreth). Many vines and but few fruit. Ribbed and slightly netted, flesh green, size 8 by 12.

63. *Anne Arundel* (Landreth). Large melon, 6 by 8½ inches, ribs shallow, distinct, and heavily netted, flesh green.

64. *Atlantic City* (Landreth). Medium in size, pineapple in shape, 6 by 10 inches, dark background netted and ribbed. Flesh green, medium productiveness.

65. *Improved Jenny* (Landreth). A typical dark green Hackensack type. Fruit very uniform, 5½ inches in diameter, lightish green flesh of fair quality.

66. *Acme* (Landreth). Dark green, small, oblong, 4 by 5½ inches, peaked at stem end, flesh green, productive, ribbed and netted.

67. *Citron* (Landreth). Large, dark green, ribbed, partly netted and rest smooth, rather distorted, all sizes, productive, rather late, flesh salmon.

68. *Ward's Nectar* (Gregory). Dark, round, 5½ inches in diameter, ribbed, smooth and one half netted, fairly productive but few ripened, flesh green, Gem type.

69. *McCotter's Pride* (Ferry). Large vines, fruit irregular, roundish, dark green, ribbed, slightly netted, orange red flesh, not very productive and late this season.

70. *Shippers' Delight* (Johnson & Stokes). Vines small but productive, fruit 3½ by 3½ inches, each melon having a button on the blossom end, shape round, netted and ribbed, good quality, flesh green.

71. *Togoodo* (Johnson & Stokes). Good sized, light green, smooth melons, not sufficiently mature, plants strong, large leaf.

Digitized by Google

72. *Ivy Gem* (Johnson & Stokes). Medium size, yellow-fleshed sort, skin smooth to slightly netted, lightish in color, ribbed, globular in form, not very productive this season, good quality.

73. *Golden Eagle* (Burpee). Slightly elongated melon, 5½ by 6½ inches, peaked at tip, shallow ribbed, heavily netted, regular in shape.

74. *Arlington Nutmeg* (Farquhar). Good size, 8 by 8½ inches, round to flattened, deep ribbed, netted, flesh pale yellow.

75. *Honey Drop* (Farquhar). Dark green, smooth, ribbed, slightly elongated, 5½ by 6 inches, resembles osage somewhat, flesh yellow to salmon, good quality.

76. *Cassabah* (Dreer). Large, regular, long melon, 9 to 11 inches long by 5½ to 7 inches broad, heavily netted, ribbed, darkish in grooves, flesh green, a good melon.

77. *Blenheim* (Weeber & Don). Smooth, round, grayish melon, slightly flat, 4½ by 5 inches. The fruit checks as it ripens and the vines are thick and compact. Too late for out of doors.

78. *Hero of Lockinge* (Weeber & Don). Very late to mature, vines thick, double stem, fruit but partly grown, size 4½ by 6 inches. A forcing variety.

79. *Conqueror of Europe* (Weeber & Don). But two fruit of this variety matured. Fair size, 6 by 7 inches, elongated and dark green.

80. *Netted Gem* (Burpee). Small, gem type, oval, very shallow ribs, netted, green fleshed. Ripens early and is very productive.

81. *Queen of All* (Salzer). Oblong, shallow ribbed, netted, flesh salmon. Ripens rather late.

82. *Nectar of Angels* (Salzer). Good size, white melon, 7½ by 7½ inches, deep ribbed, lightly netted and has a tendency to check as it approaches ripening, yellow when ripe, flesh pale yellow, flavor not very sweet though good.

83. *No. 555* (Buckbee). A round, smooth, netted, dark green variety. Too late.

84. *Superior* (Vaughan). Small, round, 4 by 5 inches, dark green variety, fruit checks as it approaches ripening stage, no ribs, somewhat flattened, flesh green. Productive but late.

85. *True Jenny Lind* (Vaughan). Small, Gem type, flattened, shallow ribbed, netted. This variety in an adjoining plot ripened much earlier than in this test. Flesh green, fine flavor, prolific and early. A very desirable variety.

86. *Giant Chicago Market* (Vaughan). Medium sized, 6½ by 6½ inches, round, green flesh, shallow ribs, netted. Medium productive but rather late.

87. *Improved Cantaloupe* (Vaughan). Medium to large and long, 7½ by 12 inches, lightish color but dark green in grooves,

Digitized by Google

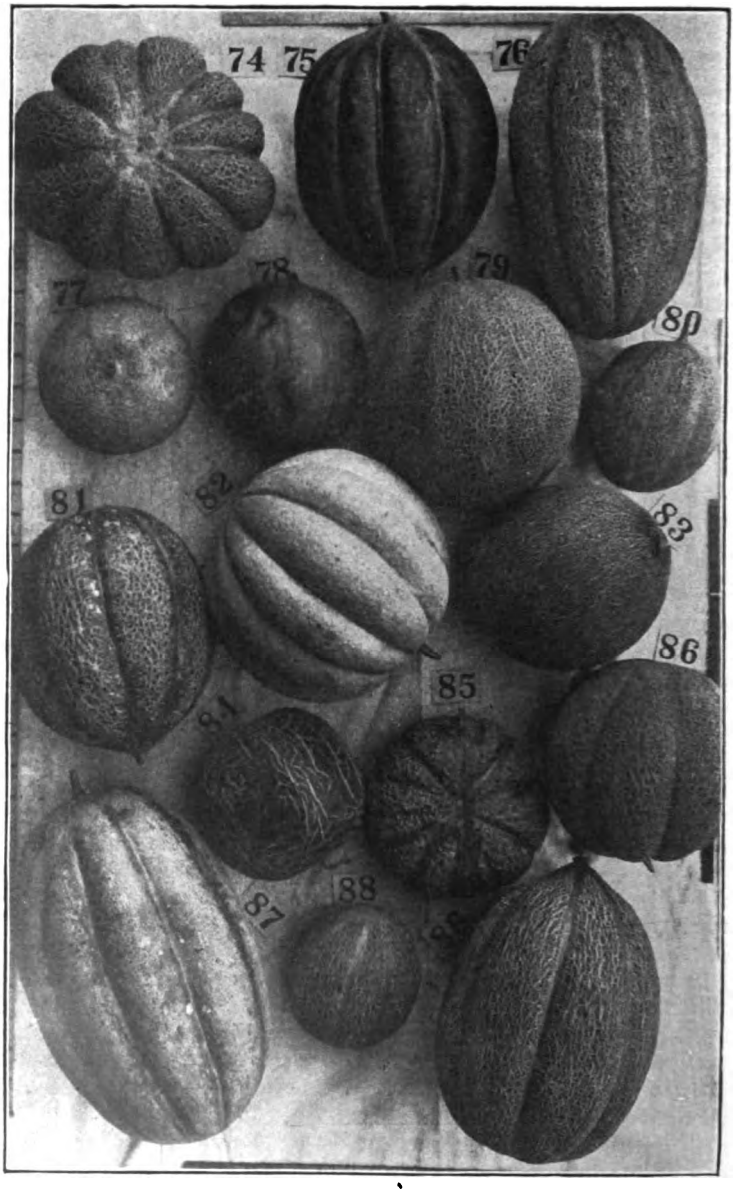


FIG. 6. VARIETIES OF MUSKMELONS.

74. Arlington Nutmeg.
75. Honey Drop.
76. Cassabah.
77. Blenheim's Orange.
78. Hero of Lockinge.
79. Conqueror of Europe.
80. Netted Gem.
81. Queen of All.
82. Nectar of Angels.
83. Buckbee No. 555.
84. Superior.
85. True Jenny Lind.
86. Giant Chicago Market.
87. Improved Cantaloupe.
88. Oval Netted Gem.
89. Southern Beauty.

Digitized by Google

deep ribbed and fruit tapers at ends, flavor much like Long Yellow (54), fairly prolific. Not as good as Granite State (37).

88. *Oval Netted Gem* (Vaughan). Small Gem type, oval, regular, 4 by 5 inches, elongated, very shallow ribs, netted. Prolific and desirable.

89. *Southern Beauty* (Vaughan). Elongated, 6½ by 8 inches, dark green, netted and shallow ribbed, good flavor, green flesh. Not very productive.

90. *Montreal Nutmeg* (Vaughan). Flat, 6½ by 8 inches, dark green, deep, large checks appear as fruit ripens, ribbed, netted. Too late.

91. *Princess* (Vaughan). Dark green, size 5½ by 8 inches, oblong, ribbed and thinly netted. Too late.

92. *Perfection* (Vaughan). Good size, 7 by 7 inches, round, Hackensack form and appearance only a darker green, fairly early, regular and productive, flesh pale yellow, deeply ribbed and netted.

93. *Paul Rose* (Vaughan). Small Gem type, oval, 4½ by 6 inches, salmon flesh, shallow ribbed and coarsely netted, extra flavor. Regular and productive.

94. *Round Netted Gem* (Vaughan). Small Gem type, oval, shallow ribs, coarse nettings, green flesh. Early and productive.

95. *Kinsman Queen* (Banning). Medium to large, flattened, deep ribbed, not netted, drab before ripe taking on a yellow tint as it ripens, flesh salmon, good flavor. Very productive and fairly early.

96. *Rocky Ford* (Henderson). Small Gem type, resembles Netted Gem type in every particular.

REJECTED LIST

The following list of thirty-two varieties are thought to be too late for general growing in the North. The basis for their rejection is on account of their not ripening at least four fruit on two hills before September 20.

1. Apple-shaped Cantaloupe.
2. Triumph.
4. Melrose.
5. Cannon Ball.
6. Green-Fleshed Osage.
8. Netted Beauty.
12. Lone Star.
13. Miller's Cream.
14. Jersey Belle.
19. Perfected Delmonico.
21. Market.
22. Tip Top.
27. New Hybrid.
28. Triumph.
34. Columbus.
38. Carmes.

Digitized by Google

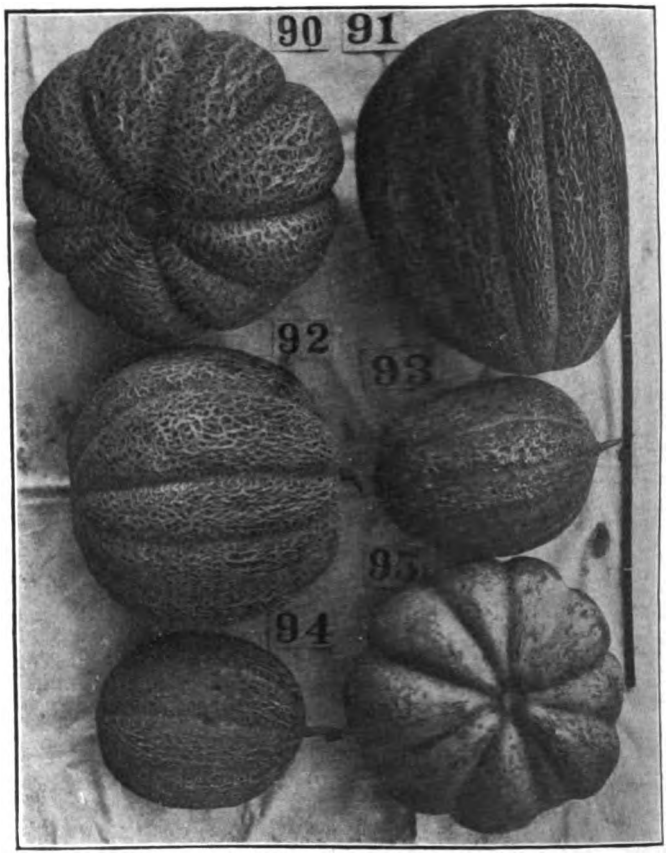


FIG. 7. VARIETIES OF MUSKMELONS.

90. Montreal Nutmeg.
91. Princess.
92. Perfection.
93. Paul Rose.
94. Round Netted Gem.
95. Kinsman Queen.

Digitized by Google

39. Shumway's Giant.
43. Bay View.
51. Banana.
60. Large White French.
62. Large Black Paris.
64. Atlantic City.
69. McCotter's Pride.
71. Togoodo.
75. Honey Drop.
77. Blenheim's Orange.
78. Hero of Lockinge.
79. Conqueror of Europe.
83. Buckbee No. 555.
89. Southern Beauty.
90. Montreal Nutmeg.
91. The Princess.

The following varieties also are discarded for reasons indicated:

3. Extra Early Grand Rapids; cracks open badly.
11. No. 88, too small.
15. Mango; valuable only for pickles.
70. Shippers' Delight; very small.

CREAM OF THE VARIETIES FOR THE NORTH

The following list of muskmelons consisting of forty-two varieties is thought to contain those best suited for northern conditions. Each of these varieties has ripened at least one third or more of its total fruit (ripe and green) before September 20.

7. Cosmopolitan.
9. Golden Gem.
10. Captain.
16. Emerald Gem.
18. Newport.
23. Rose Gem.
25. Long Island Beauty.
29. Earliest Ripe.
30. Cosmopolitan.
32. Satisfaction.
33. Jenny Lind.
35. Pineapple.
37. Granite State.
41. Early Nutmeg.
44. Delmonico.
45. Extra Early Hackensack.
46. New White Japan.
47. Skillman's Fine Netted.
48. Christiana.
49. Extra Early Cantaloupe.
50. Champion Market.
52. Surprise.
53. Chicago Nutmeg.
54. Long Yellow.
56. Casaba.
58. Bird Cantaloupe.
59. Missouri.
63. Anne Arundel.
65. Improved Jenny.
66. Acme.
67. Citron.
68. Ward's Nectar.
74. Arlington Nutmeg.
76. Cassabah.
80. Netted Gem.
81. Queen of All.
82. Nectar of Angels.
85. True Jenny Lind.
87. Improved Cantaloupe.
88. Oval Netted Gem.
94. Round Netted Gem.
95. Kinsman Queen.

Digitized by Google

LIST OF BEST TO RECOMMEND FOR THE NORTH

Of the Gem type, try any of the following: No. 88, Oval Netted Gem; No. 57, Golden Netted Gem; No. 80, Netted Gem; No. 23, Rose Gem; No. 93, Paul Rose (yellow flesh); No. 16, Emerald Gem (yellow flesh).

Of the medium type, No. 45, Extra Early Hackensack; No. 95, Kinsman Queen; No. 32, Satisfaction; No. 53, Chicago Nutmeg; No. 65, Improved Jenny; No. 46, New White Japan; No. 82, Nectar of Angels; No. 49, Extra Early Cantaloupe; No. 66, Acme.

Of the large long type, No. 37, Granite State; No. 54, Long Yellow; No. 87, Improved Cantaloupe.

Digitized by Google

Digitized by Google

Digitized by Google

This book should be returned to the Library on or before the last date stamped below.

A fine of five cents a day is incurred by retaining it beyond the specified time.

Please return promptly.

DUE FEB 28 41

Digitized by Google

Digitized by Google